

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

BULLETIN 63

PENNSYLVANIAN BRACHIOPODS
OF OHIO

by

Myron T. Sturgeon

Richard D. Hoare

COLUMBUS

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Chapter 1

INTRODUCTION

LOCATION AND EXTENT OF AREA

This study is restricted to brachiopods found in the marine units of the Pennsylvanian System in Ohio. Exposures of these units are found in the eastern part of the State in a belt extending from Lawrence County in the south to Lake County in the north (fig. 1). This belt includes parts or all of 33 counties and covers an area of more than 11,000 square miles.

No effort was made to follow the extensions of this belt into neighboring states, although it is realized that some differences in faunal composition and distribution may occur in Pennsylvanian marine units elsewhere within the Appalachian basin. The Pennsylvanian rocks in Ohio lie on the western margin of the Pennsylvanian System and form part of the Appalachian Plateau of the central Appalachian Mountains.

PURPOSE AND SCOPE OF INVESTIGATION

The major purpose of this investigation is to determine the extensiveness of the brachiopod faunas by identifying the forms present, by determining their stratigraphic ranges, and by determining to some degree their geographic distribution. It is believed that this information will enhance the possibility of recognition and correlation of stratigraphic units in the Pennsylvanian System in Ohio, and such knowledge will, in turn, aid in research and in development of the economic resources contained within these strata. Further, this information will eventually help to complete our knowledge of the evolution of the brachiopods and, as studies of other groups of fossils are completed, will provide a portion of the interpretation of the paleoecologic history of the Pennsylvanian Period. Systematic paleontology, that is, classification of the brachiopods present, and stratigraphic distribution of the brachiopods are stressed more in this investigation than are geographic distribution and paleoecologic significance. Further collecting and study of all fossil groups are necessary before geographic distribution can be detailed and paleoecologic analysis can be completed.

METHOD OF INVESTIGATION

Collections of Pennsylvanian invertebrate fossils which have been made over the past thirty years and

stored at Ohio University form the major basis for this investigation. These collections contain more than 30,000 specimens of brachiopods from 346 localities in the Pottsville, Allegheny, and Conemaugh Groups of the Pennsylvanian System in Ohio (appendix). In numerous cases more than one collection was made from a particular locality. The study has proceeded in stages with the analysis of each related group of brachiopods made separately.

Type specimens and other specimens have been borrowed from a number of institutions and individuals for comparative purposes. Many of these borrowed specimens had been collected from other parts of the United States and helped to substantiate the identification of the forms present in Ohio. Specimens previously collected and described from Ohio were also used where they were available.

In a few cases statistical analyses, following the procedures of Imbrie (1956, 1959), were made on populations from specific localities to help support the systematic position of closely related forms. This was done for most of the chonetids (table 4) and for species of the genus *Composita* except for *C. elongata* (table 21). Random samples of 50 specimens were selected, where possible, out of populations which contained a larger number of specimens. Analyses of several populations of chonetids from Illinois, Missouri, and Oklahoma are included for comparative purposes. This type of analysis was not performed for other forms because of the crushed and fragmental nature of the specimens, the lack of closely related forms, or the small number of individual specimens present from any one locality.

Specimens were cleaned by the use of an ultrasonic cleaner, a vibrating tool, and a teasing needle. Excavation of valve interiors, which is very time consuming, was done where possible so that internal characteristics could be studied. Serial sections of several forms were cut, also to help determine internal characteristics, by the use of a parallel grinding machine. Numerous specimens were so poorly preserved that specific identification was impossible.

Stratigraphic distributions of the forms present were compiled mainly on the basis of the specimens in the collections at Ohio University. Reported occurrences by previous investigators were included in the overall distribution. Differences in systematic nomenclature

between present usage and that of previous workers have been reconciled where possible, and where impossible the occurrences have been omitted.

All illustrated specimens, including type specimens for new species and varieties, have been placed in the paleontological repository of Orton Museum at The Ohio State University. These specimens are des-

ignated by OSU numbers. Several chonetid specimens illustrated for comparative purposes came from the repositories of the Peabody Museum at Yale University (YPM), the University of Missouri (MU), the United States National Museum (USNM), and the Illinois Geological Survey (IGS). Representative specimens from the Ohio University collections, where possible, have been deposited in the collections at Bowling Green State University, the University of Michigan, the University of Missouri, the United States National Museum, the Chicago Museum of Natural History, and the Illinois Geological Survey, with the remainder kept at Ohio University.

The relative size designations used in the systematic descriptions are: small - less than 20.0 mm; medium - 20.0-50.0 mm; and large - over 50.0 mm. The relative abundance of occurrence of specimens is: rare - 4 or less; common - 5-14; and abundant - 15 or more.

Systematic designations above generic rank have been omitted. Recent classifications as given by Muir-Wood and Cooper (1960), Muir-Wood (1962), and Williams and Rowell (*in* Moore, 1965) may be consulted for taxonomic designations above the generic level.

PREVIOUS INVESTIGATIONS

A number of paleontologists have touched to some extent on the Pennsylvanian brachiopods in Ohio. In most cases no attempt was made to make a complete investigation based upon thorough collecting; the work generally consisted of descriptions of a few forms which had come to the attention of the investigator. In a few cases efforts have been applied to the systematic description and discussion of the forms present in specific marine zones or within a particular stratigraphic sequence.

The earliest record in which brachiopods are described and illustrated from this part of the stratigraphic section in Ohio was by Morton (1836), whose description of a few species associated with the coal beds was an appendix to Hildreth's report on the bituminous coal deposits in the Ohio valley. Meek (1875) described several species of brachiopods from the Coal Measures of Ohio; most, however, were specimens collected from the Waverly Group of the Mississippian System and not from the Pennsylvanian System. Whitfield (1882, 1891, 1893) described four species of brachiopods from the Pennsylvanian strata in Hocking and Muskingum Counties. In 1887 Herrick, in his discussion of the geology of Licking County, included descriptions and illustrations of 19 species from the Flint Ridge region.

The first attempt to make a systematic study of the Ohio Pennsylvanian brachiopods was by Mark (1910), in a study of the Mercer limestone. This was followed by her study of the faunas of the Conemaugh Group.

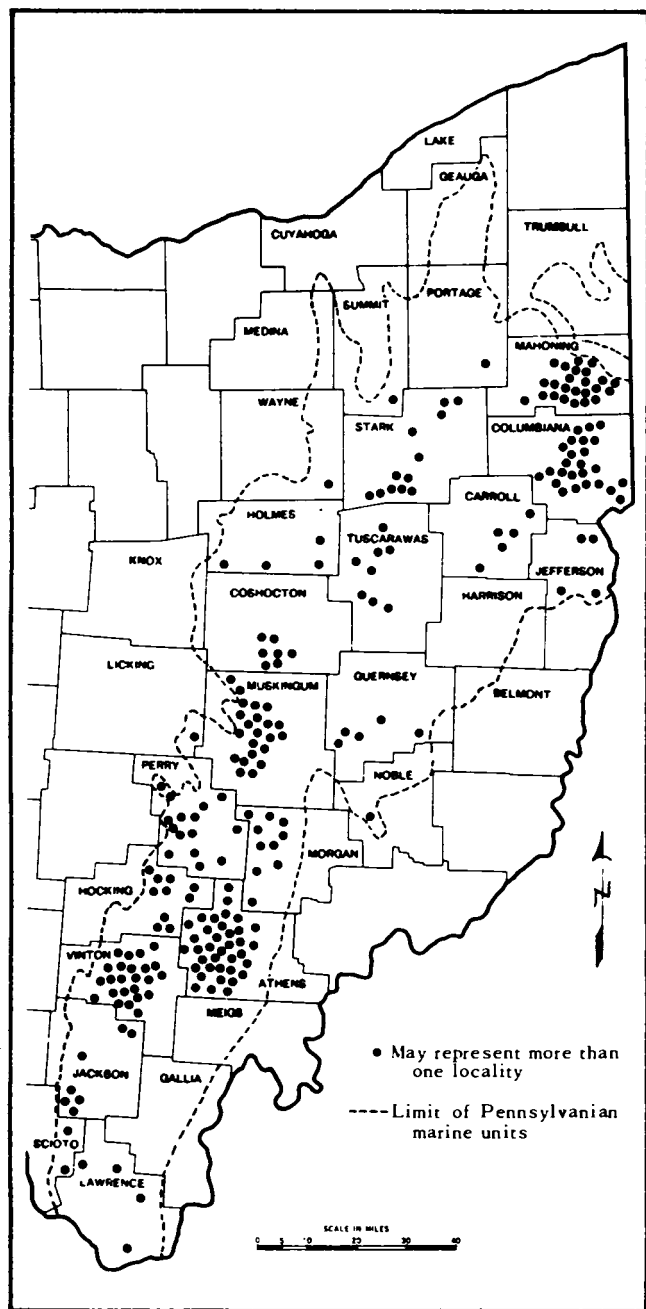


FIGURE 1.—General distribution of collecting localities for Pennsylvanian brachiopods in eastern Ohio.

Several species were illustrated and described although most forms were noted only in a systematic listing in which their occurrence in the various marine layers was indicated. Morningstar (1922) made a detailed study of the Pottsville faunas in which most forms of the brachiopods were described and illustrated. She also noted their distribution in the marine units of the Pottsville and to some extent in the lower beds of the Allegheny Group. In the 1930's Sturgeon (1933, 1936) began his studies of the stratigraphy and faunas of the Allegheny Group. Although not concentrating on the brachiopods, the collections built up during this 33-year interval form the primary basis for the present study. Laird (1937) discussed the stratigraphy and faunas of the Portersville unit in Muskingum County and presented a list of the faunas present. Taber (1951) described the faunas of the Vanport limestone in Ohio. Numerous other publications of the Ohio Geological Survey and theses and dissertations at various universities include minor discussions or lists of fossils from various units of the Pennsylvanian sequence within the State.

In addition to the reports dealing with the occurrence of various Pennsylvanian brachiopods in Ohio there are several authors whose publications contain references to these organisms in rocks of the same age elsewhere in the Appalachian basin. Among these are Cox (1857); Raymond (1910), who discussed and illustrated some of the Allegheny and Conemaugh faunas of western Pennsylvania; Price (1914, 1916a, b, 1920), who discussed the Pennsylvanian geology of areas in West Virginia and listed and described some of the invertebrate faunas; Morse (1931), who described the Pennsylvanian invertebrates of Kentucky; Lintz (1958), who described the invertebrate faunas of the Ames and Brush Creek units in Maryland; and Williams (1960), who discussed the marine and fresh-water fossiliferous units of the Pottsville and Allegheny Groups in west-

ern Pennsylvania, listed the faunas present, and illustrated some of them. Other publications describing the geology of the Appalachian basin outside of Ohio include lists of invertebrate fossils present in the Pennsylvanian units.

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Chapter 2

STRATIGRAPHY

Brackish-water and marine fossils are known in approximately 25 members of the lowest three stratigraphic groups (Pottsville, Allegheny, and Conemaugh) of the Pennsylvanian System in Ohio (table 1). None are definitely known in the upper part of the Conemaugh Group or in the overlying Monongahela Group. Cross and Schemel (1956, p. 38) have, however, reported brackish-water fossils in Monongahela strata of West Virginia.

The members bearing brackish-water and marine fossils are quite diversified in lithology. They range from calcareous limestones to shaly, flinty, and/or ferruginous, limestones or from flints to calcareous, shaly, and/or ferruginous flints; from black carbonaceous shales to gray, calcareous, and clayey and/or silty shales; and include even clay ironstones.

These fossiliferous beds are normally only a few inches to several feet thick, but several limestones are 15 to 20 or even more feet thick and in places fossiliferous shales are 30 or more feet in thickness. The fossiliferous beds are distributed at more or less regular intervals through more than 700 feet of strata. Figures derived mostly from the generalized geologic section of Ohio's rocks (Stout, 1930, 1943, 1947) indicate that brackish-water and marine fossiliferous members have a total thickness of 63 feet and an average individual thickness of 30 inches and that the coals over which those members normally lie average roughly 20 feet apart. These data also reveal that brackish-water and marine beds comprise approximately 9 percent of the total thickness and published reports disclose that the greater amount of this thickness is marine. It should be remembered that the above figures are only averages and that in the field actual thicknesses may vary considerably for different portions of the section and at different geographic localities for the same parts of the section. Another item to note is that thickness figures for most brackish-water and marine members are undoubtedly too small. At many localities a considerable thickness of fossiliferous shale overlies the limestone unit, and these fossiliferous shales have been overlooked in many places. Hence many recorded stratigraphic sections do not show the complete thickness of the shales. It is likely that most fossil collections have been made from the limestones and from the more conspicuously fossiliferous shales adjacent to the limestones.

It was long ago recognized that in many areas Pennsylvanian strata were repeated vertically in a definite sequence. J. M. Weller (1930, p. 102) has proposed the term *cyclothem* for a single succession, and many geologists have since used that term. Sturgeon (1958, p. 39-42) has summarized some features and problems of the cyclothem concept, and parts of that summary follow:

Pennsylvanian and Permian strata at many localities were deposited under a more or less regular succession of varying environmental conditions that was repeated many times during those periods. As a result certain definite succession of strata represents one succession of changing sedimentary conditions, and each sequence of strata matching one depositional cycle is now called a *cyclothem*...

Cyclothems differ somewhat from one region to another and in different parts of the stratigraphic section in the same region. An ideal or typical cyclothem in Kansas is somewhat different from one in Illinois, which in turn differs in detail from one in Pennsylvania. Stout (1931, p. 197-202) pointed out that in Ohio cyclothems of the lower Pennsylvanian (Pottsville and lower Allegheny) vary from those in the middle Pennsylvanian (upper Allegheny and lower and middle Conemaugh), and that cycles of the upper Pennsylvanian (upper Conemaugh and Monongahela) and Permian (Dunkard) are more or less alike but differ from [typical upper Pennsylvanian and Permian cyclothems described by Cross and others (1950, p. 99-100)]. Hence, any ideal cyclothem must be selected arbitrarily and pertain to a selected locality or part of the stratigraphic column and, for the lower Pennsylvanian in Ohio, is usually considered to include the [members shown in figure 2].

.... In Ohio the more complete cyclothems of the upper Allegheny and lower and middle Conemaugh series approach an ideal cyclothem in completeness. Cyclothems below the Middle Kittanning cyclothem lack fresh water limestones and those above the Skelley limestone lack marine members with the exception of thin inconspicuous brackish limestones and shales....

Cyclothems that occur in the upper Conemaugh, Monongahela, and Dunkard series of Athens County are characterized locally, in part, by a facies of red and variegated shales and mudstones (Arkle, 1953, p. 2-8) (collectively called *redbeds* in this report), either bedded or massive; by thick nodular, bedded, or massive limestones, often earthy or marly; by sandstones locally reduced in coarseness and thickness; and by very thin coals and underclays. In fact, the underclays are at many localities less than an inch thick, and the coals may be represented by a mere sooty or carbonaceous film on top of the underclay. Discovery and recognition of these thin coals and underclays in field work is not as difficult as one might anticipate since the red shales and mudstones below those horizons are massive and break irregularly with a starch-like fracture, and those above are bedded and fissile and can be split parallel to bedding into flakes or sheets. Fossil clams, clam-like estherids (shelled crustaceans), and plants also occur, but not uni-

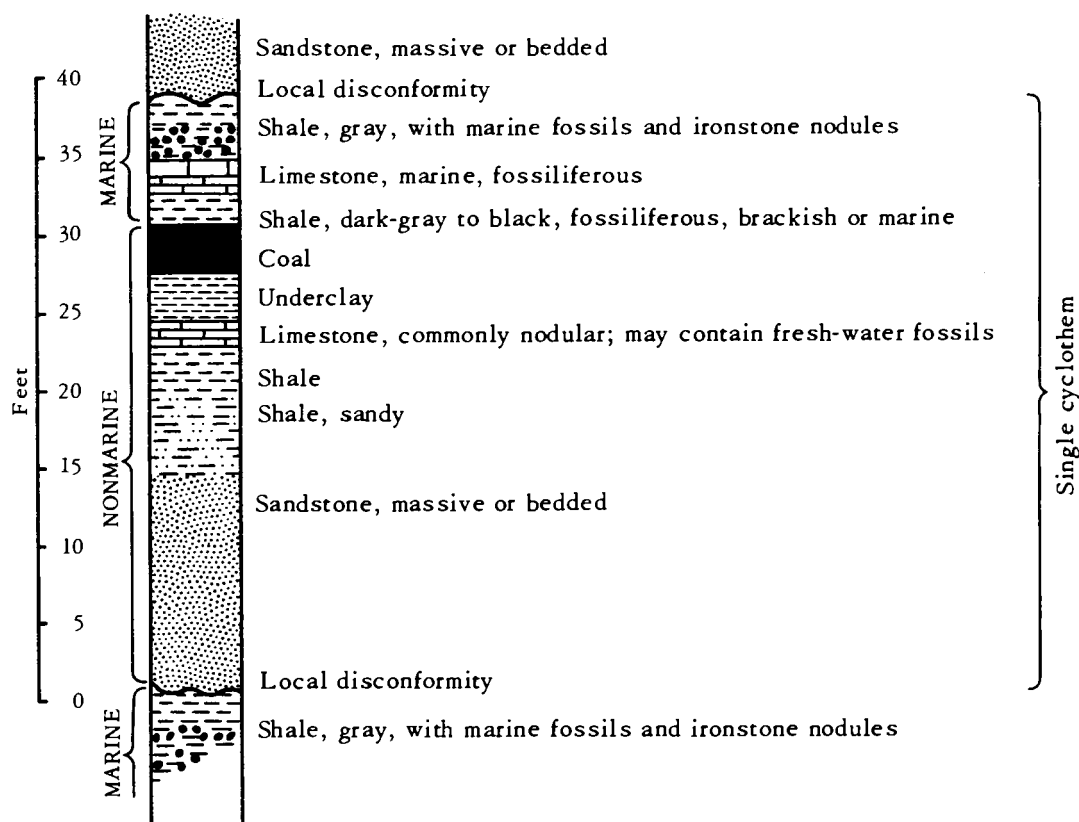


FIGURE 2.—Members present in a complete cyclothem in the Lower Pennsylvanian System in Ohio (from Sturgeon and others, 1958).

versally, in the bedded rocks just over the coal horizons (Arkle, 1953, p. 4). No dark limestones containing brackish water fossils have been recognized in Athens County.

Lateral or facies change in cyclothems from one region to another and the vertical differences among cyclothems in the same region offer numerous challenges in correlation of strata and for interpretation of origin. Thickness and degree of completeness of different cyclothems vary widely; for example, the Bolivar cyclothem is incomplete and thin, while the underlying Lower Freeport cyclothem is nearly complete and much thicker. Member beds fluctuate in thickness even to the extent of pinching out completely, or vary in character from one rock type to another in short horizontal distances. Hence a cyclothem, when traced laterally, can show thickening or thinning of individual members or in its entire thickness, gain or lose members, change widely in its lithologic characteristics, appear or disappear, or exhibit features that render correlation difficult. On the other hand, the lateral extent of certain members and their features, such as the nodular and shaly lithology (physical characteristics) of the Portersville limestone or the persistent partings in the Middle Kittanning (No. 6) coal can be surprisingly widespread. In spite of all inconsistencies it is possible to trace and to correlate members and cyclothems across geographic areas ranging from townships or less to states or larger in size...

Flint (1951) and Merrill (1950) have named Ohio cyclothems, with both uniformly and differently named members, from their coal members, and that method is used in this report....

A typical cyclothem is partly marine and partly nonmarine, and the cyclothem boundary can most logically be placed between marine and nonmarine beds — at the top of the coal or at the base of the sandstone. Although by no means perfect, the boundary at the coal's roof has several cogent points in its favor, and were it not for long established and often illogical use of member names, that limit for cyclothems would have been employed in this report. The top of the coal, or in the absence of the coal the top of the underclay, is one of the more easily found and recognized planes of separation in an entire cyclothem. Coal and/or underclay or any overlying marine member are more persistent in regional extent and therefore are most useful for purposes of correlation. In cyclothems containing marine members this plane marks the separation of the underlying nonmarine rocks from the overlying marine rocks more certainly than the boundary above or below where marine rocks are succeeded upward by nonmarine ones. Furthermore, coal, underclay, and marine limestones are valuable mineral resources and hence are desirable units for mapping purposes in preparation of geologic, economic, and structural maps.

Table 1 is modified from that part of Stout's generalized stratigraphic section for Ohio between the Harrison ironstone at the base of the Pennsylvanian System and the Skelley limestone high in the Conemaugh Group. These two members mark the lower and upper limits of known brackish-water and marine fossils in

the Pennsylvanian strata of Ohio. Additions and changes to Stout's section include new and revised stratigraphic names, including names for four additional marine members, boundaries as well as names for

all cyclothems, and minor changes in lithologic descriptions published since Stout's work. This table is not intended to be a final revision of this part of the Pennsylvanian section exposed in Ohio.

TABLE 1.—*Lower Conemaugh, Allegheny, and Pottsville stratigraphic section*

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Conemaugh	Duquesne	Skelley	Limestone; bedded and similar to Ames limestone or nodular and ferruginous in shale; fossiliferous, marine, local		4	20	7
		Duquesne	Coal, shaly, thin, local		1		
			Underclay, local	1	6		
			Limestone, nodular, fresh-water	1	8		
			Redbed, calcareous, local	6	0		
		Lower Grafton	Shale and/or sandstone	11	0		
	Gaysport	Gaysport	Limestone, nodular or bedded, sandy, fossiliferous, marine	1	0	17	0
			Shale and/or sandstone; locally fossiliferous marine shale	16	0		
	Ames	Ames	Limestone, light-gray; in many places greenish or pinkish; semicrystalline, bedded, massive, fossiliferous, marine, persistent	1	6	16	9
			Coal, shaly, thin, local		3		
			Underclay and clay shale, variable composition, persistent	1	0		
			Shale and/or sandstone, persistent	14	0		
	Harlem	Harlem	Coal, shaly, persistent	1	0	30	6
			Underclay, siliceous	2	0		
		Rock Riffle	Limestone, nodular, fresh-water, local	4	6		
		Round Knob	Redbed, varicolored, calcareous	12	0		
		Saltsburg	Shale and/or sandstone	11	0		
	Upper Bakerstown	Upper Bakerstown	Coal, local	1	0	26	0
			Underclay and clay shale	4	0		
		Ewing	Limestone, gray to bluish-gray, ferruginous, nodular, nonmarine	1	0		
		Cow Run	Shale and/or sandstone; sandstone locally massive	20	0		

TABLE 1.—Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Conemaugh	Anderson	Portersville	Shale and limestone, gray to black; soft to ferruginous shale with dark nodular limestone; fossiliferous, marine	2	0	27	2
		Anderson	Coal, thin, persistent	1	8		
			Underclay, calcareous, ferruginous, shaly, persistent	3	0		
		Bloomfield	Limestone, gray, nodular, fossiliferous, nonmarine, local	1	6		
		Bakerstown	Shale and/or sandstone; sandstone locally massive	19	0		
	Wilgus	Cambridge	Limestone; widely varied in color, composition, and lithology; fossiliferous, marine, persistent	4	0	32	8
		Wilgus	Coal, nonpersistent; locally minable in southern Ohio	2	0		
			Underclay, shaly, local	3	8		
		Buffalo	Shale and/or sandstone; sandstone locally massive	23	0		
	Brush Creek	Brush Creek	Limestone and shale; north of Muskingum County, mostly black sandy shale with nodules and lenses of dark limestone; locally southward as two beds of cherty and ferruginous limestone; fossiliferous, marine, persistent	20	0	40	4
			Coal, thin, local		4		
			Underclay and clay shale, varicolored	10	0		
			Shale and/or sandstone	10	0		
	Mason	Mason	Shale, dark, fossiliferous, marine, local	5	0	30	0
			Coal, local		6		
			Underclay, local	2	6		
		Upper Mahoning	Redbed, varicolored, local	12	0		
			Shale and/or sandstone; sandstone locally massive	10	0		
	Mahoning	Mahoning	Coal; mostly thin; locally minable in northeastern Ohio	1	0	42	0
		Thornton	Underclay, nonpersistent	5	0		
		Lower Mahoning	Limestone, gray to bluish-gray, ferruginous; nodular and embedded in clay; fossiliferous, nonmarine, nonpersistent	2	0		
			Redbed, varicolored, local	9	0		
			Shale and/or sandstone; sandstone locally massive	25	0		

TABLE 1.—*Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued*

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Allegheny	Upper Freeport		Shale, black, carbonaceous, fossiliferous, brackish-water, local		4	29	4
		Upper Freeport	Coal No. 7, nonpersistent, locally thick and minable	3	0		
			Underclay and shale	7	0		
			Limestone and marly shale, fossiliferous, nonmarine, local	2	0		
			Shale and/or sandstone; with ferruginous zones	17	0		
	Bolivar	Bolivar	Coal, thin, local		3	18	6
			Underclay, flint and plastic, rather persistent	5	0		
		Shawnee	Limestone, bedded or nodular, locally ferruginous, fossiliferous, nonmarine, local	1	3		
		Bolivar	Shale and/or sandstone	12	0		
	Lower Freeport	Dorr Run	Shale, dark-gray to black, carbonaceous, fossiliferous, marine, local	1	9	31	3
		Lower Freeport	Coal No. 6A, patchy, locally thick and minable	1	0		
			Underclay	2	6		
			Limestone, nodular, fossiliferous, nonmarine, local	1	0		
			Shale and/or sandstone; sandstone locally thick	25	0		
	Upper Kittanning	Upper Kittanning	Coal, present in only a few places	1	0	11	10
			Underclay, local		10		
			Shale and/or sandstone	10	0		
	Middle Kittanning	Washingtonville	Shale, gray to black, carbonaceous, fossiliferous, marine, rather persistent, in east-central and northeastern Ohio only	4	0	22	0
		Middle Kittanning	Coal No. 6, minable, persistent	4	0		
			Underclay, siliceous, persistent	3	6		
		Leetonia	Limestone, bedded or nodular, fossiliferous, nonmarine, local		6		
		Middle Kittanning	Shale and/or sandstone	10	0		
	Strasburg	Tuscarawas	Shale, dark-gray, fossiliferous, marine, local	1	6	9	0
		Strasburg	Coal, thin, local		6		
		Oak Hill	Underclay, flint and plastic, rather persistent	4	0		
		Strasburg	Shale and/or sandstone	3	0		

TABLE 1.—Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Allegheny	Lower Kittanning	Columbiana	Shale and nodular limestone, gray, fossiliferous, marine; rather persistent; in east-central and northeastern Ohio only	4	0	14	4
		Lower Kittanning	Coal No. 5, minable, persistent	2	4		
			Underclay, persistent	5	0		
			Shale and/or sandstone, nonpersistent	3	0		
	Lawrence	Lawrence	Coal, shaly, local		4	14	6
			Underclay, flint and plastic, persistent	6	0		
			Shale and/or sandstone	8	2		
	Scrubgrass	Ferriferous	Ironstone, clay ironstone, and limonite, fossiliferous, marine, local		8	12	2
		Vanport	Limestone, flint, and shale, fossiliferous, marine	6	0		
		Scrubgrass	Coal, present in only a few places		6		
			Shale and/or sandstone	5	0		
	Clarion	Clarion	Coal No. 4A, patchy, locally minable	4	0	19	6
			Underclay, flint and plastic	5	0		
		Canary	Ironstone, nodular; in southern Ohio only, local		6		
		Clarion	Shale and/or sandstone; sandstone locally massive	10	0		
	Winters	Winters	Coal; in Jackson and Vinton Counties, local	1	0	5	0
			Underclay, generally absent	4	0		
	Ogan	Zaleski	Flint and limestone, dark-gray to black, locally shaly or ferruginous, fossiliferous, marine; in Jackson and Vinton Counties, local	1	0	29	0
		Ogan	Coal; in Jackson and Vinton Counties, local	1	0		
			Underclay; in Jackson and Vinton Counties, local	2	0		
			Shale and/or sandstone	25	0		
	Brookville	Putnam Hill	Limestone and shale, gray, quite persistent; in southern and northeastern Ohio only	4	0	22	0
		Brookville	Coal No. 4, persistent	4	0		
			Underclay, plastic, persistent	4	0		
		Homewood	Shale and/or sandstone; sandstone locally massive	10	0		

TABLE 1.—*Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued*

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Pottsville	Tionesta		Coal, thin, local	1	0	30	0
		Tionesta	Underclay, plastic, persistent	5	0		
			Shale and/or sandstone; sandstone locally massive	24	0		
	Bedford	Big Red Block	Ironstone, blocky clay ironstone, and/or limonite, sparingly fossiliferous, marine, local		4	13	0
		Upper Mercer	Limestone and/or flint and shale, dark-bluish-gray to black, fossiliferous, marine	1	8		
		Bedford	Coal, patchy	1	0		
			Underclay, siliceous	3	0		
			Shale and/or sandstone	7	0		
	?	Sand Block	Ironstone, blocky or nodular; siliceous clay ironstone or limonite; locally fossiliferous, marine; in southern Ohio only, local		6	4	0
			Shale and/or sandstone	3	6		
	Upper Mercer	Upper Mercer	Coal No. 3A, local	1	0	15	0
			Underclay, siliceous, plastic	3	0		
			Shale and/or sandstone	11	0		
	Middle Mercer	Little Red Block	Ironstone, nodular clay ironstone, and limonite, sparingly fossiliferous; in southern Ohio only, local		3	13	0
		?	Shale, siliceous	1	9		
		Lower Mercer	Limestone and shale; dark-bluish-gray to black limestone and shaly limestone, locally ferruginous or siliceous; similarly colored shale, very fossiliferous, marine, very persistent	2	0		
			Coal, thin, persistent		6		
			Underclay, siliceous, plastic	3	6		
		Middle Mercer	Shale and/or sandstone	5	0		
	Flint Ridge	Flint Ridge	Coal, thin, local		6	9	6
			Underclay, flint and plastic	4	0		
			Shale and/or sandstone	5	0		
	Lower Mercer	Boggs	Limestone, flint, ironstone, and/or shale, fossiliferous, marine, nonpersistent; in east-central and southern Ohio only		6	28	6
		Lower Mercer	Shale, siliceous	1	0		
			Coal No. 3, thin, persistent	1	0		
			Underclay, siliceous	3	0		
			Shale and/or sandstone; sandstone locally massive	23	0		

TABLE 1.—Lower Conemaugh, Allegheny, and Pottsville stratigraphic section—Continued

Group	Cyclothem	Unit	Description	Thickness			
				Unit		Cycle	
				Ft	In	Ft	In
Pottsville	Vandusen	Lowellville or Poverty Run	Limestone, ironstone, and shale, dark-gray to black; limestone resistant; shale with ironstone nodules locally; fossiliferous, marine; in east-central and northeastern Ohio only, local	1	0	21	0
		Vandusen	Coal, thin, nonpersistent	1	0		
			Underclay	2	0		
			Shale and/or sandstone	17	0		
	Bear Run	Bear Run	Shale and ironstone; blue-gray shale and red or gray black-band ironstone, fossiliferous, brackish-water(?); in southern Ohio only, local	2	0	30	6
			Coal, local	1	6		
			Underclay, siliceous	3	0		
		Massillon	Shale and/or sandstone; sandstone locally massive	24	0		
	Quakertown	Quakertown	Shale; no detailed descriptive or thickness data available; fossiliferous, brackish-water, local	?	?	19+	0
			Coal No. 2, locally minable	2	0		
			Underclay, siliceous	5	0		
			Shale and/or sandstone	12	0		
	?	Guinea Fowl	Ironstone, siliceous clay ironstone, and limonite, fossiliferous, brackish-water(?); in southern Ohio only, local		3	6	0
			Shale, siliceous	5	9		
	Anthony	Anthony	Shale, dark, fossiliferous, brackish-water	1	0	25	3
			Coal, thin, local		3		
		Sciotoville	Underclay, flint and plastic	4	0		
		Anthony	Shale and/or sandstone	20	0		
	Sharon	Sharon	Ironstone and shale, buff to brown, siliceous; soft ironstone or dark-gray shale, fossiliferous, marine		3	25	0
			Shale, siliceous	4	9		
			Coal, patchy, locally minable	3	0		
			Underclay, siliceous	2	0		
			Shale, siliceous, nonpersistent	5	0		
			Conglomerate and/or sandstone, local; locally 100 ft or more thick	10	0		
	Harrison	Harrison	Ironstone, buff to red, limonitic, siliceous, coarse, fossiliferous, marine, local		6		6

Chapter 3

STRATIGRAPHIC SIGNIFICANCE AND PALEOECOLOGY

GENERAL

The marine units in the Pennsylvanian System in Ohio contain an abundance of brachiopods. The separation of the marine units by relatively thick nonmarine units results in a less gradual faunal change than would be the case in a continuous marine series. This allows a more distinct zonation to be established than is true in most other parts of the continent, especially the midcontinent region. This is especially true of the chonetids, productids, and spiriferids. Table 2 illustrates the stratigraphic distribution of all brachiopods in the Ohio Pennsylvanian. The nonmarine units are not included in the stratigraphic sequence in table 2 nor are the units to scale.

POTTSVILLE GROUP

The Pottsville Group is distinguished by the presence of *Cleiothyridina orbicularis* var. *crassalamellosa* n. var., *Schizophoria resupinoides*? (Cox), *Rugosochonetes delicatus* n. sp., *Plicochonetes dotus* n. sp., *Desmoinesia muricatina* var. *missouriensis* (Girty), *Antiquatonia costellata* n. sp., *Juresania nebrascensis* var. *inflata* n. var., and *Krotovia paucispina* n. sp. Although abundant in the Pottsville, *Mesolobus striatus* Weller & McGehee, *Kozlowskia haydenensis* (Girty), *Neospirifer goreii* (Mather), *Anthracospirifer opimus* (Hall), *A. rockymontanus* (Marcou), and *A. occiduus* (Sadlick) are not restricted and are found also in the lower units of the Allegheny Group.

The genus *Rugosochonetes* is reported by Muir-Wood (1962) to extend into the Namurian Stage. The presence of *R. delicatus* in the Pottsville extends the upper range of this genus. The upper limit of the genus *Plicochonetes* is given as the base of the Namurian by Muir-Wood (1962). "*Chonetes*" *arkansanus* Mather (1915) from the Morrowan of Arkansas may belong to this genus. *P. dotus* from the Lower Mercer is the youngest known representative of this genus and extends the range into the lower portion of the Westphalian Stage.

?*Oehlertella stoutella* appears to be restricted to the lowermost Pottsville units, the Harrison and Sharon ironstones. *Cleiothyridina orbicularis* var. *crassalamellosa*, *Hustedia miseri*, *Plicochonetes dotus*, and *Desmoinesia muricatina* var. *missouriensis* are distinctive

of the Lower Mercer unit and of beds slightly below it.

ALLEGHENY GROUP

The Allegheny Group is distinguished by *Composita girtyi* Raymond, *Wellerella tetrahedra* Dunbar & Condra, *Mesolobus mesolobus* (Norwood & Pratten), *M. lioderma* Dunbar & Condra, *Eolissochonetes fragilis* n. sp., *Chonetinella crassiradiata* Dunbar & Condra, and *Reticulatia rugatua* n. sp. Mesolobids are the most characteristic chonetid in the Allegheny Group. As they disappear in the Upper Allegheny they seem to be replaced by the genus *Chonetinella*. *Chonetinella crassiradiata* is a rare form in the Allegheny Group and the genus does not become abundant until the lower units of the Conemaugh Group. This replacement also occurs in the Upper Desmoinesian of Missouri and Kansas, where *C. plebeia* is found abundantly when the genus *Mesolobus* disappears. Individual marine units in the Allegheny Group apparently do not have restricted forms.

CONEMAUGH GROUP

Forms which are diagnostic of the Conemaugh Group include *Derbyia parvicostata* n. sp., *Wellerella osagensis* (Swallow), *Enteletes hemiplicatus* (Hall), *Orthotetes conemaughensis* n. sp., *Punctospirifer kentuckyensis* var. *amesi* n. var., *Composita ohioense* n. sp., *C. magna* Newell, *Neochonetes semiacanthus* (Lutz), *N. granulifer* (Owen), *Chonetinella alata* (Dunbar & Condra), *C. flemingi* (Norwood & Pratten), *Hystericulina wabashensis* (Norwood & Pratten), *Pulchratia* cf. *P. ovalis* (Dunbar & Condra), *P. symmetrica* var. *regularis* n. var., *Echinaria semipunctata* (Shepard), *E. moorei* (Dunbar & Condra), *Antiquatonia portlockiana* var. *crassicostata* (Dunbar & Condra), *Reticulatia huecoensis* (R. E. King), *Juresania nebrascensis* var. *pulchra* n. var., *Linoproductus* cf. *L. platyumbonus* Dunbar & Condra, *L.* cf. *L. magnispinus* Dunbar & Condra, and *L. oklahomae* Dunbar & Condra.

In the Conemaugh Group the Cambridge is distinguished by the occurrence of *Echinaria semipunctata*. The Ames contains *Wellerella osagensis*, *Orthotetes conemaughensis*, *Pulchratia* cf. *P. ovalis*, *Echinaria moorei*, *Reticulatia huecoensis*, *Linoproductus oklahomae*, and *Punctospirifer kentuckyensis* var. *amesi*.

Neochonetes semiacanthus is found mainly in the Ames but questionably occurs also in the Gaysport and Skelley units. *Composita magna* is found only in the Gaysport and Skelley units.

FUSULINID - BRACHIOPOD CORRELATION

One of the most reliable groups of organisms for time correlations is that of the fusulinids. On the left side of table 3 the marine zones in Ohio which contain fusulinids are correlated with some of the major marine zones in the Eastern Interior and Western Interior basins. These correlations are based upon studies by Thompson (1936, 1948, 1953), Thompson and Shaver (1964), Thompson, Shaver, and Riggs (1959), Dunbar and Henbest (1942), Smyth (1957), and Bebout (1963) and indicate that the Upper Pottsville Group, from at least as low as the Boggs limestone and shale, is equivalent to the Lower Kewanee Group and Lower Desmoinesian Series in the basins to the west. The basal Allegheny marine zone, the Putnam Hill limestone and shale, is correlated with the Creal Springs Limestone Member of Illinois and questionably with the Cheltenham Clay Member of Missouri. The Vanport limestone and shale is equivalent to the Seahorne Limestone and the Tiawah Limestone, of Illinois and Missouri, respectively.

Using the correlation based upon the fusulinids the stratigraphic distribution of a number of the more significant brachiopods is illustrated on the right side in table 3. These distributions are based upon work of Morningstar (1922), Mark (1912), Dunbar and Condra (1932), Wanless (1958), Hoare (1961), and upon the present study. Considerable differences in stratigraphic ranges between the three basins are apparent in many instances, differences which may be caused by the length of time needed for migration of various species, by the presence of intermittent physical barriers between the basins during the Pennsylvanian Period, or by the lack of acceptable environments in the different basins during certain time spans.

In general, in the area under study, the number of species and varieties of brachiopods is considerably smaller than that reported by Dunbar and Condra (1932) and Hoare (1961) from the Western Interior basin. In the present study and in those by Mark (1912) and Morningstar (1922) 93 species and varieties representing 42 genera are distinguished, whereas 46 genera and 130 species were reported from the Western Interior basin. A few additional species have been reported by several other authors from both basins. This discrepancy in numbers of forms indicates either conditions less favorable to life during a greater portion of the Pennsylvanian Period in the Appalachian basin or the impossibility of forms migrating into this basin. Notably missing from the Appalachian basin are representatives of the genera *Derbyoides*, *Schuchertella*, *Strepatorhynchus*, *Orthothetina*, *Tornquistia*, *Lissochonetes*,

Poikilosakos, *Teguliferina*, *Shumardella*, *Rhynchopora*, and *Cryptocanthia*. All of these genera are reported from the Western Interior basin and several of them from the Eastern Interior basin. In addition to the fact that the marine conditions in the Western Interior basin were more continuous during the early and middle portions of the period than was the case in the Appalachian basin, such conditions continued through the later Pennsylvanian in the Western Interior basin. The Upper Pennsylvanian in Ohio, the Monongahela Group, is nonmarine, so that the marine faunas disappeared much earlier in the Appalachian basin, a fact which helps to account for the smaller diversity of fauna in this area.

PALEOECOLOGY

No attempt is made here to make a comprehensive analysis of the chemical and physical environment in relation to the stratigraphic and geographic distribution of the brachiopods in the region under study. This study must wait for completion of the study of the entire Pennsylvanian fauna and for detailed study of the enclosing strata. Brachiopods, in themselves, do not appear to be distinctive indicators of water depth, variation in salinity, or water temperature but, being sessile benthonic organisms, they do appear to be restricted by the substrate available upon which to develop. At the present time it would seem that their greatest paleoecological significance might be in substrate relationships and in their interrelationships with other organisms.

Brachiopods are used as a substrate by many other organisms. Barnacles, bryozoans, corals, echinoderms, gastropods, protozoans, worms, and other brachiopods are among the types of animals which use brachiopod shells as a substrate or which have in some other way made use of the shell. The relationships between the brachiopods as host and the attached epifaunal organisms cannot always be determined. In many cases the brachiopod may be dead and there is no life interrelationship between the organisms. In a few instances it is possible to see that the host has been deformed as it grew because of the attached organism or that the distribution of the epifauna upon the host indicates some relationship between them in their feeding habits. Organisms such as barnacles, gastropods, and sponges may bore into the shell while the brachiopod is alive and may have a parasitic, commensal, or mutual relationship.

Several instances of epifauna being attached to the brachiopods have been encountered in this study. The most common form is a type of the foraminiferal genus *Serpulopsis*, whose thin curved tubes are present on a large number of specimens. Specimens of the genus *Spirorbis*, a worm, are abundant on shells of *Composita* in the Cambridge unit. Elliptical borings made by acrothoracic barnacles are present on specimens of *Neochonetes* (pl. 9, fig. 17) and *Linoproductus*. These

TABLE 2.—Stratigraphic distribution of the Pennsylvanian brachiopods in Ohio

Group	Marine units	Species				
Washington	Washington shale					
	(no definite marine units)					
Monongahela	Skelley limestone and shale					
	Gaysport limestone and shale					
	Ames limestone and shale					
	Portersville shale and limestone					
	Cambridge limestone and shale					
	Upper Brush Creek limestone and shale					
	Lower Brush Creek limestone and shale					
Conemaugh	Mason shale					
	(unnamed shale)					
	Dorr Run shale					
	Washingtonville shale					
Allegheny	Tuscarawas shale					
	Columbiana shale and limestone					
	Vanport limestone, flint, and shale					
	Zaleski flint, limestone, and shale					
	Putnam Hill limestone and shale					
Pottsville	Upper Mercer flint, limestone, and shale					
	Sand Block ironstone					
	Lower Mercer ironstone					
	Lower Mercer limestone and shale					
	Boggs limestone, flint, and ironstone					
	Lowellville or Poverty Run limestone and shale					
	Bear Run shale					
	Quakertown shale					
	Anthony shale					
	Sharon ironstone					
	Harrison ironstone					

TABLE 2.—Stratigraphic distribution of the Pennsylvanian brachiopods in Ohio—Continued

Species		
<i>Rhipidomella carbonaria</i>		<i>Neochonetes semiacanthus</i>
<i>Isogramma millepunctata</i>		<i>Neochonetes granulifer</i>
		<i>Chonetinella alata</i>
		<i>Chonetinella flemingi</i>
		<i>Chonetinella verneuliana</i> var.
		<i>Chonetinella plebeia</i>
	<i>Chonetinella crassiradiata</i>	
	<i>Eolissochonetes fragilis</i>	
	<i>Mesolobus lioderma</i>	
	<i>Mesolobus mesolobus</i>	
	<i>Mesolobus striatus</i>	
	<i>Mesolobus obsoletus</i>	
<i>Plicochonetes dotus</i>		
<i>Rugosochonetes delicatus</i>		
<i>Kozlowskia haydenensis</i>		<i>Kozlowskia splendens</i>
		<i>Hystriculina wabashensis</i>
<i>Desmoinesia muricata</i>		
<i>Desmoinesia muricata missouriensis</i>		<i>Pulchratia symmetrica regularis</i>
		<i>Pulchratia</i> cf. <i>P. ovalis</i>
<i>Echinaria</i>	<i>semipunctata knighti</i>	<i>Echinaria semipunctata</i>
		<i>Echinaria moorei</i>
		<i>Leptalosia ovalis</i>

TABLE 2.—Stratigraphic distribution of the Pennsylvanian brachiopods in Ohio—Continued

Group	Marine units	Species				
Washington	Washington shale					
	(no definite marine units)					
Monongahela	Skelley limestone and shale					
	Gaysport limestone and shale					
	Ames limestone and shale					
	Portersville shale and limestone					
	Cambridge limestone and shale					
	Upper Brush Creek limestone and shale					
	Lower Brush Creek limestone and shale					
Conemaugh	Mason shale					
	(unnamed shale)					
Allegheny	Dorr Run shale					
	Washingtonville shale					
	Tuscarawas shale					
	Columbiana shale and limestone					
	Vanport limestone, flint, and shale					
	Zaleski flint, limestone, and shale					
	Putnam Hill limestone and shale					
Portsville	Upper Mercer flint, limestone, and shale					
	Sand Block ironstone					
	Lower Mercer ironstone					
	Lower Mercer limestone and shale					
	Boggs limestone, flint, and ironstone					
	Lowellville or Poverty Run limestone and shale					
	Bear Run shale					
	Quakertown shale					
	Anthony shale					
	Sharon ironstone					
	Harrison ironstone					

TABLE 2.—Stratigraphic distribution of the Pennsylvanian brachiopods in Ohio—Continued

Species		
<i>Cancrinella boonensis</i>	<i>Cancrinella</i> sp. <i>Krotovia</i> sp. <i>Wellerella tetrahedra</i>	? <i>Fimbriaria</i> sp. <i>Wellerella osagensis</i>
<i>Hustedia miseri</i>	<i>Hustedia mormoni</i> <i>Composita subtilita</i> <i>Composita ovata</i> <i>Composita argentea</i> <i>Composita elongata</i> <i>Composita girtyi</i>	<i>Composita ohioense</i> <i>Composita magna</i>
<i>Cleiothyridina orbicularis</i> <i>Cleiothyridina orbicularis crassamellosa</i> <i>Punctospirifer kentuckyensis</i>	<i>Cleiothyridina orbicularis</i> <i>Punctospirifer kentuckyensis</i>	<i>Punctospirifer kentuckyensis amesi</i>
<i>Neospirifer goreii</i> <i>Neospirifer cameratus</i>	<i>Neospirifer cameratus</i> <i>Neospirifer latus</i>	<i>Neospirifer dunbari</i>
<i>Anthracospirifer occiduus</i> <i>Anthracospirifer rockymontanus</i> <i>Anthracospirifer opimus</i>	<i>Anthracospirifer occiduus</i> <i>Anthracospirifer rockymontanus</i> <i>Anthracospirifer opimus</i>	
	<i>Crurithyris planoconvexa</i> <i>Phricodothyris perplexa</i> <i>Beecheria bouldens</i>	

TABLE 3.—Correlation of fusulinid zones in the Appalachian basin with zones in the Western Interior and Eastern Interior basins and corresponding stratigraphic distribution of selected brachiopods

Western Interior basin		Eastern Interior basin		Appalachian basin	
Virgilian	Iatan { <i>Triticites exiguus</i> <i>T. irregularis</i> <i>T. secalicus</i>	Shumway { <i>Triticites turgis</i> <i>T. pauper</i>	Gaysport <i>Triticites skinneri</i>	Skelley (no fusulinids)	
Missourian	Stanton { <i>Triticites exiguus</i> <i>T. irregularis</i> <i>T. secalicus</i> <i>T. neglectus</i>	Omega { <i>Triticites ohioensis</i> <i>T. venusta</i>	Ames { <i>Triticites skinneri</i> <i>T. cullomensis</i>	Portersville <i>Triticites ohioensis</i>	
	Argentine { <i>Triticites exiguus</i> <i>T. irregularis</i>				
	Winter set Bethany Falls { <i>Triticites ohioensis</i> <i>T. winter setensis</i> <i>Wedekindellina ultimata</i> <i>Fusulina fallsensis</i>				
Desmoinesian	Fort Scott { <i>Fusulina girtyi</i> <i>F. hauorthi</i> <i>F. lucasensis</i> <i>F. occultifrons</i> <i>F. marmatonensis</i> <i>F. boonensis</i> <i>F. higgensvillensis</i>	St. David { <i>Fusulina girtyi</i> <i>F. illinoisensis</i> <i>F. hauorthi</i>	Washingtonville (no fusulinids)	Columbiana <i>Fusulina</i> sp.	
	Verdigris { <i>Wedekindellina euthysepta</i> <i>Fusulina cadyi</i> <i>F. lee</i> <i>F. boonensis</i> <i>F. euryteines</i>				
	Tiawah { <i>Wedekindellina euthysepta</i> <i>Fusulina lee</i> <i>F. euryteines</i>				
	Cheltenham (no fusulinids)				
	Seville (no fusulinids)				
Atokan	Burgner { <i>Fusulinella clarki</i> <i>F. searighti</i>	Seville { <i>Fusulinella iowensis</i> <i>F. stouti</i> <i>F. gephyrea</i>	Upper Mercer Lower Mercer Boggs { <i>Fusulinella iowensis</i> <i>F. stouti</i>	Lowellville (no fusulinids)	

TABLE 3.—Correlation of fusulinid zones in the Appalachian basin with zones in the Western Interior and Eastern Interior basins and corresponding stratigraphic distribution of selected brachiopods—Continued

[illegible]

borings pass through the valve but no indication of repair by the brachiopod could be seen, indicating that the host was probably dead at the time. Specimens of the inarticulate brachiopod *Crania modesta* were found attached to specimens of *Chonetinella* (pl. 8, fig. 15), *Composita*, *Kozlowskia*, and *Neochonetes* (pl. 9, fig. 18). No preferred orientation could be seen in these associations, although numerous specimens of a closely related genus, *Petrocrania*, from the Devonian, show marked orientation along the edges of brachiopod shells, presumably in a feeding relationship.

Bryozoans are commonly found incrusting portions of brachiopod shells. Several different forms were seen on specimens of *Antiquatonia*, *Chonetinella*, *Composi-*

ta, *Linoproductus*, *Neochonetes*, and *Neospirifer*. In one case (pl. 5, figs. 1, 2) the association appears to be symbiotic, with growth of the bryozoan colony on the host while the latter was alive, the bryozoans benefiting from the waste products in the exhalent current. The growth of the bryozoan in this particular instance modified the growth of the chonetid shell to some extent.

Epifaunal elements were found on brachiopods in practically every marine unit where large numbers of specimens were present. There seems to be a greater concentration of epifaunal elements on the specimens in the Conemaugh Group, especially in the Ames limestone and shale.

Chapter 4

SYSTEMATIC PALEONTOLOGY

Genus *Lingula* Bruguière, 1797

Lingula carbonaria Shumard

Pl. 1, figs. 1-3

Lingula carbonaria Shumard, 1858, p. 215; Hoare, 1961, p. 21, 22, pl. 1, figs. 1, 2 (see for synonymy).

Shell small, subrectangular to suboval in shape, with greatest width near mid-length. Valves of approximately equal size and convexity; median areas flattened in many specimens; lateral margins subparallel to gently convex; beaks marginal; brachial valve slightly shorter than pedicle; and surfaces marked by numerous closely spaced growth lines.

Internally, median septa lacking and muscle scars not impressed. Measurements of numerous specimens from several stratigraphic positions give the following minimum-maximum dimensions: length, 2.9-11.4 mm, width 1.7-6.9 mm.

Discussion.—*Lingula carbonaria* is by far the most common species of this genus in the Pennsylvanian of Ohio. Price (1914, 1916b) has named two other species, *L. lemniscata* and *L. kanawhensis*, from the Pottsville of West Virginia. Morningstar (1922) noted an isolated occurrence of *L. kanawhensis* from the Lower Mercer unit in Ohio, but this form is not present in our collections. *L. kanawhensis* is a larger, more rectangular form with the posterior margins more nearly at right angles to the lateral margins than is the case in *L. carbonaria*. *L. lemniscata* has a more acute posterolateral region than does *L. carbonaria*.

Occurrence.—Rare in the Zaleski and Portersville units; rare to common in the Brush Creek unit; and rare to abundant in the Lower Mercer, Putnam Hill, Vanport, Columbiana, Washingtonville, and Dorr Run (Lower Freeport) units. Also reported from the Harrison, Anthony, Quakertown, Lowellville, and Boggs units by Morningstar (1922) and from the Cambridge and Ames units by Mark (1912).

Repository.—Hypotypes, OSU-27028 to 27030.

Lingula lemniscata? Price

Pl. 1, fig. 4

Lingula lemniscata Price, 1916, p. 691, pl. 30, fig. 3; Dunbar & Condra, 1932, p. 33, 34, pl. 1, fig. 3.

Shell small, elliptical in shape, with greatest width anterior to mid-length. Posterolateral margins diverging from beak at an acute angle before rounding into lateral margins just posterior to mid-length; lateral margins gently convex, rounding smoothly into evenly convex anterior margin; and surfaces marked by closely spaced growth lines.

Specimen measures 14.2 mm long and 6.0 mm wide.

Discussion.—One incomplete specimen is tentatively assigned to this species. The small angle of divergence of the posterior margins from the beak is diagnostic. *L. kanawhensis* Price was reported by Morningstar (1922) from the Lower Mercer in Perry County. None of the specimens in our collections are similar to the description and illustrations by Price (1914) nor could Morningstar's specimen be found in the collections at The Ohio State University.

Occurrence.—Rare in the Putnam Hill unit.

Repository.—Hypotype, OSU-27031.

Genus *Trigonoglossa* Dunbar & Condra, 1932

Trigonoglossa nebrascensis (Meek)

Pl. 1, figs. 5, 6

Lingula scotia var. *nebrascensis* Meek, 1872, p. 158, pl. 8, figs. 3a, b.

Glossina nebrascensis Schuchert, 1897, p. 224.

Lingulipora nebrascensis Girty, 1915, p. 50, pl. 6, figs. 11, 11a; Morse, 1931, p. 307, pl. 46, figs. 5-6a.

Glossina waverlyensis Morningstar, 1922, p. 169, 170, pl. 7, fig. 4.

Trigonoglossa nebrascensis Dunbar & Condra, 1932, p. 37-39, pl. 1, figs. 5, 6.

Shell small to medium, subtriangular in shape, with greatest width in anterior third of shell. Beaks small; lateral margins forming an acute angle before rounding narrowly into anterior margin, which is only slightly curved; posterior portions of lateral margins incurved; valve surfaces nearly flat, being slightly convex; valve surfaces marked by sharp, concentric lirae which are more widely spaced anteriorly, 19-22 per cm; and interspaces flat, several times width of lirae and marked by faint, closely spaced growth lines.

Internal features not observed. Measurements made

on three partially crushed and fragmental specimens give average length as 21.1 mm and average width as 17.6 mm.

Discussion.—*Trigonoglossa nebrascensis* can be distinguished from *T. kentuckyensis* (Morse), the only other species of this genus with which it might be confused, by the more widely spaced lirae and less transverse shape in the former species. Lirae in *T. kentuckyensis* number up to 30 per cm on the anterior portion of the shell whereas 20 lirae per cm, in the same portion of the shell, is common in *T. nebrascensis*.

Occurrence.—Common in the Lower Mercer unit and rare in the Vanport and Columbiana units.

Repository.—Hypotypes, OSU-15218, 27032.

Genus *Orbiculoidea* d'Orbigny, 1847

Orbiculoidea missouriensis (Shumard)

Pl. 1, figs. 7-11

Discinia missouriensis Shumard, 1858, p. 221.

Discinia manhattanensis Meek & Hayden, 1859, p. 25.

Orbiculoidea manhattanensis Hall & Clarke, 1891, pl. 5, fig. 12; —, 1892, pl. 4, fig. 20.

Orbiculoidea missouriensis Morningstar, 1922, p. 172, 173; Dunbar & Condra, 1932, p. 42-45, pl. 1, figs. 12-17; Hoare, 1961, p. 22, 23, pl. 1, figs. 3-5.

Shell small, circular to suboval, generally slightly longer than wide. Brachial valve broadly conical; apex approximately one-fourth length of shell from posterior margin; anterior slope gently convex, posterior slope straight to gently concave; and surface marked by closely spaced, fine fila, becoming spaced more regularly and with wider interspaces towards margin of valve. Pedicle valve with apex near center; anterior slope gently concave, posterior slope convex; pedicle track narrow, closed by listrium posteriorly; foramen small, oblique; and surface marked by numerous concentric fila becoming more widely spaced toward valve margin and more strongly developed than on brachial valve.

Brachial interior with a low, narrow median septum starting at apex and extending approximately one-half distance to anterior margin. Other features not observed.

Measurements of four specimens from various units and localities give the following average dimensions: length, 8.4 mm, and width, 7.9 mm.

Discussion.—*Orbiculoidea missouriensis* is one of the more common forms of this genus in the Pennsylvanian System. It may be differentiated from mature forms of *O. capuliformis* (McChesney) by its small size although it may be difficult to distinguish from immature individuals of the latter species. *Lindstroemella patula* (Girty) is impossible to differentiate from *O. missouriensis* without seeing the Y-shaped septal

structure on the interior of the brachial valve of the former. It is possible that several of the specimens we have tentatively assigned to *O. missouriensis* belong to *L. patula*.

Occurrence.—Questionably present in the Boggs unit; rare in the Upper Mercer, Putnam Hill, Columbiana, Washingtonville, and Cambridge units; rare to common in the Lower Mercer, Vanport, Zaleski, and Brush Creek units; and common to abundant in the Dorr Run (Lower Freeport) unit. Also reported as present in the Lowellville unit by Morningstar (1922) and in the Portersville and Ames units by Mark (1912).

Repository.—Hypotypes, OSU-27033 to 27035.

Orbiculoidea capuliformis (McChesney)

Pl. 1, figs. 12-15

Discinia capuliformis McChesney, 1860, p. 72; —, 1868, p. 23, pl. 2, fig. 20.

Orbiculoidea capuliformis Dunbar & Condra, 1932, p. 46, 47, pl. 1, figs. 20-22 (see for synonymy); Hoare, 1961, p. 23, 24, pl. 1, figs. 8-9.

Shell small to medium, circular to subcircular, slightly wider than long. Brachial valve moderately convex; apex located about one-third of shell length from posterior margin; anterior slope convex, posterior slope concave; and surface marked by fine fila of unequal size and spacing. Pedicle valve with apex near center; anterior slope slightly concave, posterior slope convex; pedicle track relatively narrow, closed by listrium anteriorly; foramen small, oblique; and surface marked by numerous fine, concentric fila, coarser and more regularly arranged than on brachial valve.

Brachial interior with low median septum from apex to about mid-length anteriorly and with numerous faint vascular markings. Other features not observed.

Measurements of an uncrushed, partly exfoliated specimen are: length, 29.2 mm, width, 30.3 mm, and height (of brachial valve only), 10.4 mm.

Discussion.—In the North American Pennsylvanian System *Orbiculoidea capuliformis* is easily distinguishable by its size. Two other species, *O. meekana* (Whitfield) and *Oehlertella stoutella* Morningstar, approach the size of *O. capuliformis* but the former is a much more convex form and the latter has the brachial beak located much nearer the posterior margin.

Occurrence.—Rare in the Upper Mercer, Putnam Hill, and Brush Creek units and rare to abundant in the Vanport unit. Also reported from the Harrison, Sharon, and Boggs units by Morningstar (1922). Mark (1912) reports *O. convexa* (Shumard) from the Portersville; however, there are no illustrations, descriptions, or specimens for study and it is possible that her specimens were *O. capuliformis*.

Repository.—Hypotypes, OSU-27036 to 27038.

Orbiculoidea meekana? (Whitfield)

Pl. 1, figs. 16-19

Discinia meekana Whitfield, 1882, p. 228; ---, 1891, p. 598, pl. 15, figs. 1-3.

Orbiculoidea meekana Morningstar, 1922, p. 171, 172.

Shell small to medium and circular to suboval in outline. Brachial valve strongly convex; apex located approximately one-third of shell length from posterior margin; anterior slope convex, posterior slope concave; and surface marked by numerous concentric fila, more widely spaced toward margin.

Pedicle valve and valve interiors not observed. Measurements of a nearly complete brachial valve are: length, 21.9 mm, width, 23.6 mm, and height, 12.3 mm.

Discussion.—Two collections appear to fit Whitfield's original description. Pedicle valves are lacking in both collections. The lack of illustration makes adequate comparison difficult. The strong convexity of the brachial valve and the location of the beak appear to be distinctive. It is possible that some of the crushed specimens identified as *Orbiculoidea capuliformis* (McChesney) belong to this species.

Occurrence.—Common in the Quakertown unit and questionably present in the Lower Mercer and Washingtonville units. In addition Morningstar (1922) reports it as present in the Upper Mercer unit.

Repository.—Hypotypes, OSU-9794, 27039.

Genus *Lindstroemella* Hall & Clarke, 1890*Lindstroemella patula* (Girty)

Pl. 1, fig. 20

Roemerella patula Girty, 1911, p. 125; ---, 1915, p. 51, pl. 6, figs. 1-9; pl. 10, figs. 14a, b.

Lindstroemella patula Dunbar & Condra, 1932, p. 49, 50, pl. 1, figs. 8-11.

Shell small to medium, subcircular to suboval in shape, and width may be slightly greater than length. Brachial valve conical; apex approximately one-third of shell length from posterior margin; anterior slope convex; posterior slope concave; and surface marked by closely spaced, fine fila. Pedicle valve with apex subcentral; anterior slope concave, posterior slope convex; pedicle track narrow, extending to near valve margin; and surface marked by concentric fila.

Brachial interior with median septum passing through apex, longer anteriorly; a pair of ridges forming a Y-shaped structure, converging on median septum anteriorly before they diverge; and surface marked by indistinct, many-branched pallial lines.

A large nearly complete pedicle valve measures 21.1 mm in length and 24.3 mm in width. A small ex-foliated brachial valve is 6.0 mm long and 5.8 mm wide.

Discussion.—This is the only species of *Lindstroemella* recognized in the Pennsylvanian System. The Y-shaped septal arrangement in the brachial valve is distinctive of the genus.

Occurrence.—Rare in the Lower Mercer and Washingtonville units. Possibly present in other Pottsville and Allegheny units.

Repository.—Hypotype, OSU-27040.

Genus *Oehlertella* Hall & Clarke, 1890*?Oehlertella stoutella* (Morningstar)

Pl. 1, figs. 21-25

Orbiculoidea stoutella Morningstar, 1922, p. 173, 174, pl. 7, figs. 5-8.

Shell small to medium and subcircular to suboval. Brachial valve broadly convex; apex submarginal; greatest height between apex and mid-length; posterior slope short, concave; anterior slope convex; and surface marked by closely spaced, concentric fila. Pedicle valve unknown.

Brachial interior with low median septum from apex to near mid-length of valve; lateral ridges diverging anterolaterally from area posterior to apex; two pairs of muscle scars lightly impressed between lateral ridges and median septum; and numerous fine, parallel sinuses near lateral and anterior margins.

Measurements on three specimens give the following average dimensions: length, 14.3 mm, width, 14.5 mm, and height (of brachial valve only), 4.7 mm.

Discussion.—This species is tentatively placed in the genus *Oehlertella* on the basis of its low convexity and submarginal apex. The internal characteristics and pedicle valve of the genus were not described by Hall and Clarke (1890) or by Meek (1875) in his description of *Discinia pleurites*, the type species. The presence of the lateral ridges in the brachial valve differentiates the genus from *Orbiculoidea* and the divergence of these ridges distinguishes it from *Lindstroemella*.

Occurrence.—Abundant in the Harrison unit. Also reported by Morningstar (1922) as common in the Sharon unit.

Repository.—Hypotypes, OSU-15219, 15220, 27041, 27042.

Genus *Crania* Retzius, 1781*Crania modesta* White & St. John

Pl. 1, figs. 26, 27

Crania modesta White & St. John, 1867, p. 118; Girty, 1915, p. 53, 54, pl. 6, figs. 12-14 (see for synonymy); Morningstar, 1922, p. 175; Kelly, 1930, p. 137, pl. 11, fig. 18; Dunbar & Condra, 1932, p. 51, pl. 1, figs. 23-26.

Petrocrania modesta Hoare, 1961, p. 25, 26, pl. 1, figs. 6, 7.

Shell small, subcircular to subpentagonal in shape, with greatest width commonly anterior to mid-length. Brachial valve roughly conical in shape with apex slightly posterior to mid-length and marked by irregular, concentric lines of growth. Pedicle valve thin, cemented down, and in many specimens distorted by ornamentation of host shell used as substrate.

Pedicle interior with thickened margin; posterior adductor scars widely spaced at posterior margin, in many cases slightly raised; and anterior adductors smaller, located just posterior of center of valve, slightly raised, closely spaced in a roughly heart-shaped area. Brachial interior not observed.

Average dimensions of two undistorted pedicle valves are: length, 8.4 mm, and width, 9.4 mm.

Discussion.—This is the only species of this genus recognized in the Pennsylvanian System of North America. It was previously placed in the genus *Petrocrania* by Shimer and Shrock (1944) and by Hoare (1961), but the thickened valve margins appear to be distinctive of the genus *Crania*.

Occurrence.—Rare in the Lower Mercer, Putnam Hill, Vanport, Columbiana, and Cambridge units. Reported by Morningstar (1922) from the Upper Mercer unit.

Repository.—Hypotypes, OSU-27044, 27045.

Genus *Meekella* White & St. John, 1867

Meekella striatocostata (Cox)

Pl. 2, figs. 1-3

Plicatula striato-costata Cox, 1857, p. 568, pl. 8, fig. 7; Meek, 1872, p. 175, pl. 5, figs. 12a-c.

Meekella striatocostata Schuchert, 1897, p. 264, 265 (see for synonymy); Dunbar & Condra, 1932, p. 125-129, pl. 16, figs. 1-10; pl. 17, figs. 3a-c.

Shell small to medium, with greatest width near mid-length. Brachial valve with small beak; hinge line about one-half width of shell; cardinal area absent; greatest convexity posterior; lateral margins rounding smoothly into anterior margin; up to nine radial costae, beginning at a distance of about 6 mm from the beak, the central costa lying in a broad, shallow sulcus which originates at the umbo; and closely spaced radial costellae, arranged in a multicostellate pattern. Pedicle valve with high, triangular cardinal area; beak small and somewhat flattened; delthyrium narrow, with angle of 22°, closed by deltidium with flat lateral areas and a narrowly rounded central area; and costae and costellae as on brachial valve, although a median sulcus is absent.

Internal features not observed. All specimens fragmentary.

Discussion.—Fragments of six specimens, all from the same locality, provide the basis for the above description. The general shell form can be determined from the fragments. *Meekella striatocostata* differs from

M. striatocostata var. *grandicosta* Dunbar & Condra by being smaller in size and having smaller costae; from *M. striatocostata* var. *ventricosa* Dunbar & Condra by being less ventricose and having fewer costae; and from *M. striatocostata* var. *convexicostata* Dunbar & Condra by being larger and less globular in form and by having flaring terminations to the costae.

Occurrence.—Six specimens, but rare, in the Cambridge unit and found only at locality Gwe-1.

Repository.—Hypotypes, OSU-27046 to 27048.

Genus *Enteleles* Fischer de Waldheim, 1825

Enteleles hemiplicatus (Hall)

Pl. 2, figs. 4-6

Spirifer hemiplicatus Hall, 1852, p. 409, pl. 4, figs. 3a, b.

Enteleles platsmouthensis Newell, 1931, p. 262, pl. 31, figs. 20-27.

Enteleles hemiplicatus Newell, 1931, p. 265, pl. 31, figs. 12-15; Dunbar & Condra, 1932, p. 60-63, pl. 11, figs. 7, 12; pl. 44, figs. 3-4a.

Shell medium in size and globose in form. Brachial valve with incurved beak; sharp, angular fold; and three angular plications on each lateral slope. Pedicle valve with high beak, arched over cardinal area; narrowly triangular delthyrium; V-shaped sulcus; and three large, angular costae on each lateral slope. Surface finely multicostellate.

Internal features not observed. A complete specimen from the Ames limestone and shale at locality CAC-2 measures 16.2 mm in length, 19.6 mm in width, and 14.5 mm in thickness.

Discussion.—Four specimens, mostly fragmentary or crushed, form the basis for the above description. The costae begin well away from the beaks, which differs from the arrangement in *E. hemiplicatus* var. *platsmouthensis* Newell, and there is not a costae within the sulcus and a biplicate fold as in *E. pugnoides* Newell.

Occurrence.—Rare to common in the Ames unit.

Repository.—Hypotype, OSU-27049.

Genus *Schizophoria* King, 1850

Schizophoria resupinoides (Cox)

Pl. 2, figs. 7-12

Orthis resupinoides Cox, 1857, p. 570, pl. 9, figs. 1-1b.

Schizophoria resupinoides Dunbar & Condra, 1932, p. 56-58, pl. 2, figs. 15-16c; [non] Mather, 1915, p. 145, 146, pl. 8, figs. 6-8.

Shell medium to large, with greatest width anterior to mid-length. Brachial valve with small beak slightly curved over long, narrow, triangular cardinal area; hinge line less than half maximum width; valve most strongly convex near umbo; and probably a broad,

shallow sulcus anteriorly. Pedicle valve with beak arched over long, narrow cardinal area and valve much more convex than brachial. Valve surface finely multicostellate.

Pedicle interior with strong plates supporting teeth; base of dental lamellae continuing as ridges bordering elongate, oval-shaped diductor scars; and adductor scars on a low, broad median septum separating diductor scars. Brachial interior with pair of widely diverging crural plates extending from cardinal process, muscle scars not impressed. Other internal features not seen. Maximum width of large brachial valve, 47.0 mm; approximate length and width of a smaller specimen, 15.8 and 20.4 mm, respectively.

Discussion.—Three partial specimens form the basis for the above short description. Tentative specific designation is based upon size and apparent presence of sulcus on the brachial valve of a large specimen and lack of sulcus on the pedicle valve of the smaller specimen, features which distinguish this species from *S. texana* Girty and *S. oklahomae* Dunbar & Condra. Morningstar (1922) reports the occurrence of *Schizophoria* in the Harrison unit but specific determination was not made.

Occurrence.—Rare in the Lower Mercer and Upper Mercer units.

Repository.—Hypotypes, OSU-27050, 27051.

Genus *Rhipidomella* Oehlert, 1890

Rhipidomella carbonaria (Swallow)

Pl. 2, figs. 13, 14

Orthis carbonaria Swallow, 1858, p. 218; Meek, 1872, p. 173, pl. 1, figs. 8a-c; Meek & Worthen, 1873, p. 571, pl. 25, fig. 4; Hall, 1883, pl. 37, figs. 1-4.

Orthis pecosi White [non Marcou], 1883, p. 120, pl. 32, figs. 20-22; Hall & Clarke, 1892, pl. 7, figs. 1-4; Keyes, 1894, p. 64.

Rhipidomella pecosi Beede, 1900, p. 96; Mark, 1912, p. 303, pl. 13, fig. 10; Girty, 1915, p. 286, 293, 299, 303; Morningstar, 1922, p. 175, 176, pl. 7, fig. 13.

Rhipidomella carbonaria Dunbar & Condra, 1932, p. 52-54, pl. 2, figs. 1-4; Hoare, 1961, p. 26, 27, pl. 1, figs. 10-12.

Shell small, with greatest width near mid-length and maximum thickness just anterior to hinge line. Brachial valve with small beak, arched over low, triangular cardinal area and notothyrium; chilidial plates not seen; hinge line less than half width of shell; greatest convexity of shell just anterior to umbonal region; lateral margins evenly rounded; and anterior margin straight or slightly sinuate because of low, broad sulcus. Pedicle valve with high beak arched over high, triangular cardinal area; delthyrium large, narrowly triangular; and deltidial plates lacking. Shell

finely punctate and valve ornamentation finely parvicostellate.

Brachial interior with ridged myophore supported by short shaft; brachiophores heavy, supported by base plates; sockets deep, subtriangular; crural plates absent; and muscle field not divided by median septum. Pedicle interior with heavy dental lamellae supporting large teeth; lamellae continuing as ridge around diductor scars; and adductor scars small, elongate, completely enclosed by large diductors.

Measurements taken on two specimens from the Ames limestone and shale give the following average dimensions: length, 8.9 mm, width, 10.5 mm, and thickness, 5.0 mm.

Discussion.—This is the only species of *Rhipidomella* occurring in our collections and the only species unquestionably recognized in the Pennsylvanian of North America. It is rather a rare form, not found at many localities.

Occurrence.—Rare to common in the Poverty Run unit and rare in the Boggs, Lower Mercer, and Ames units. Also reported in the Putnam Hill unit by Morningstar (1922) and in the Brush Creek, Cambridge, and Skelley units by Mark (1912).

Repository.—Hypotype, OSU-27052.

Genus *Isogramma* Meek & Worthen, 1870

Isogramma millepunctata (Meek & Worthen)

Pl. 2, figs. 15, 16

Chonetes? millepunctatus Meek & Worthen, 1870, p. 35; —, 1873, p. 566, pl. 25, fig. 3.

Aulacorhynchus millepunctatus Morningstar, 1922, p. 180, pl. 7, fig. 12.

Isogramma millepunctata Dunbar & Condra, 1932, p. 282-284, pl. 42, figs. 18-21.

Shell large, much wider than long, with greatest width just anterior to hinge line. Hinge line straight, rounding sharply at cardinal extremities into lateral margins which converge uniformly into anterior margin, forming a broad, elliptical shape. Valve surfaces marked by concentric, elevated fila, numbering 26-28 per cm, separated by interspaces slightly wider than the fila. Fila larger and more widely spaced toward anterior margin. Shell material abundantly and coarsely punctate.

Internal features not observed. A nearly complete external mold, when restored, measures 21.0 mm in length and 62.0 mm in width.

Discussion.—*Isogramma millepunctata* is a rare species in the Pennsylvanian System in Ohio. Only fragmentary specimens have been found. The very coarse nature of the punctae and the arrangement of the concentric fila are diagnostic of the genus. *I. renfrarum* Cooper is a much larger species with broadly convex lateral margins. *I. texanum* Cooper has a deeper shell and has a finer ornamentation than does *I. mille-*

punctata. Internal differences exist between these three species also.

Occurrence.—Common in the Lower Mercer unit and rare in the Cambridge unit.

Repository.—Hypotypes, OSU-15225, 27053.

Genus *Orthotetes* Fischer de Waldheim, 1829

Orthotetes conemaughensis n. sp.

Pl. 2, figs. 17-20

Shell medium to large, with greatest width between hinge line and mid-length. Pedicle valve with several strong varices of growth; cardinal area narrow and elongate except in region of beak, where it is produced; and delthyrium completely closed by pseudodeltidium with angle of 58° . Valve surfaces parvicostellate with 17-20 costae and costellae per cm near the anterior margin. Radial ornamentation crossed by numerous closely spaced, filate lines of growth.

Brachial valve interior with bifid cardinal process extending posteriorly, united into a median septum anteriorly; muscle scar area subcircular, bounded by a crenulate ridge and partially divided longitudinally by extension of the median septum; and surface marked by numerous small, low endospines and the reflection of the external ornamentation. Pedicle interior with short, stout teeth; dental ridges converging on posterior end of median septum, forming a small delthyrial chamber partially filled with secondary deposits; muscle field posterior, impressed, split by median septum into two subtriangular regions and with a crenulate margin; median septum high posteriorly, fused to underside of the pseudodeltidium and extending to the anterior margin of the muscle field; and surface marked by numerous fine endospines and faintly reflecting external ornamentation.

A partial brachial valve measures 49.0 mm in length and 62.0 mm in width. A nearly complete pedicle valve is 33.8 mm long and 33.0 mm wide.

Discussion.—The above description is based upon seven partial specimens from four localities. *Orthotetes conemaughensis* differs from *O. occidentalis* Lane in having a shallower pedicle valve, a narrower interarea, a lower median septum in the pedicle valve, and coarser external ornamentation. *O. mutibilis* Girty is a more gibbous form than *O. conemaughensis*, with finer surface ornamentation and a medial groove on the pseudodeltidium.

Mark (1912) reported *Derbyia robusta* (Hall) from the Ames unit. It is quite possible that a misidentification on the basis of external shape and ornamentation was made and that these specimens were representatives of *Orthotetes*. Raymond (1910) illustrates a specimen designated as *Derbyia robusta* (Hall) from the Ames Limestone of Pennsylvania; his specimen agrees closely with *O. conemaughensis*.

Occurrence.—Rare in the Ames unit.

Type locality.—The Ames limestone and shale at

locality CAc-2. The species is associated with an abundant fauna comprised of *Hustedia mormoni*, *Composita subtilita*, *Composita argentea*, *Punctospirifer kentuckyensis* var. *amesi*, *Neospirifer dunbari*, *Entelletes hemiplicatus*, *Derbyia crassa*, *Leptalosia ovalis*, *Antiquatonia portlockiana*, *Reticulatia huecoensis*, *Echinaria moorei*, *Pulchratia* cf. *P. ovalis*, *Juresania nebrascensis*, *Linoproductus prattenianus*, *Hystericulina wabashensis*, *Neochonetes granulifer*, crinoids, bryozoans, and shark teeth.

Repository.—Holotype, OSU-27054; paratypes, OSU-27055, 27056.

Genus *Derbyia* Waagen, 1884; emend. Girty, 1908

Derbyia crassa (Meek & Hayden)

Pl. 3, figs. 1-4

Orthosina crassa Meek & Hayden, 1859, p. 261.

Derbyia crassa Girty, 1915, p. 54-58, pl. 6, figs. 1-1c (see for synonymy); Morningstar, 1922, p. 176, 177, pl. 7, figs. 9, 10; Kelly, 1930, p. 138, pl. 11, fig. 4; Dunbar & Condra, 1932, p. 79-83, pl. 3, figs. 1-12; Hoare & Burgess, 1960, p. 711, 712, pl. 91, fig. 8; Hoare, 1961, p. 27-29, pl. 1, figs. 17-23.

Shell small to medium, with greatest width anterior to mid-length and slightly wider than long. Brachial valve with very narrow or obsolescent interarea; beak low and small; and surface evenly convex. Pedicle valve flat to slightly convex posteriorly; beak small, in many cases distorted; cardinal area less than one-fourth as high as wide; deltidium forming angle of approximately 47° ; and perideltidial angle of approximately 115° . Surface of valves parvicostellate with 16-18 narrow, sharp costae and costellae per cm at a distance of 1 cm from beak. Interspaces wider than costae and costellae. Fine, closely spaced lirate growth lines cross costae and costellae, giving noded appearance to radial ornamentation.

Brachial interior with low to high cardinal process with lobes divergent posteriorly and supported by plates diverging at about 90° ; sockets elongate, narrow; crura small to pronounced; median septum absent or very low; and adductor scars large, subtriangular, faintly flabellate. Pedicle interior with long, narrow teeth; median septum high posteriorly, low anteriorly, extending less than half length of valve; and muscle scars not impressed. All specimens compressed, giving distorted measurements.

Discussion.—This is undoubtedly the most common form of *Derbyia* present in our collections. Many of the fragmental specimens probably belong here although they cannot be specifically determined.

The nearly equal width and length, the position of greatest width, and the nature of the ornamentation distinguish *Derbyia crassa*. Specific differences are enumerated under other species.

Occurrence.—Rare to abundant in the Ames, Vantage, Putnam Hill, and Lower Mercer units; rare to common in the Portersville and Boggs units; common in the Washingtonville and Zaleski units; and rare in the Columbiana unit. Also reported by Morningstar (1922) from the Lowellville and Upper Mercer units and by Mark (1912) from the Brush Creek, Cambridge, and Skelley units.

Repository.—Hypotypes, OSU-27057 to 27060.

Derbyia parvicostata n. sp.

Pl. 3, figs. 5-12

Shell small to medium, with greatest width at mid-length and distinctly wider than long. Brachial valve with small beak; narrow, linear interarea; greatest height posterior to mid-length; shallow median sulcus beginning near umbo, becoming obsolescent at anterior margin; and posterolateral areas concave. Pedicle valve with small beak, slightly deformed; cardinal area approximately one-fifth as high as wide; deltidium forming angle of 40° - 45° ; perideltidial area forming angle of 110° ; surface flat to slightly convex posteriorly, becoming concave anteriorly; and posterolateral areas recurved. Valve surfaces parvicostellate, with costae and costellae fairly heavy, numbering 19-21 per cm at a distance of 1 cm from beak. Concentric, fine, closely spaced lirae growth lines giving a ridged appearance to costae and costellae. Interspaces of nearly equal width with costae and costellae.

Brachial interior with moderate to high cardinal process with lobes subparallel to divergent and supported by plates which diverge to border muscle scar area; crura small; sockets short, suboval; median septum absent; chlidium obsolescent; and muscle scars not deeply impressed. Pedicle interior with stout, suboval teeth; median septum fused to pseudodeltidium, extending past mid-length; and muscle scars not impressed. Measurements of seven complete specimens give the following average dimensions: length, 18.0 mm, width, 22.5 mm, and thickness, 7.7 mm.

Discussion.—*Derbyia parvicostata* differs from *D. crassa* (Meek & Hayden) in having subrectangular shape, recurved posterolateral areas, maximum width near mid-length, coarser costae and costellae, and greater convexity of the brachial valve and anterior concavity of the pedicle valve. The presence of the median sulcus on the brachial valve may also be distinctive. This species differs from *D. bennetti* Hall & Clarke in its regularity of shape and from most other species described by Dunbar and Condra (1932) by the presence of a median brachial sulcus, among other characteristics. *D. deer creekensis* Dunbar & Condra and *D. hooserensis* Dunbar & Condra both have a median sulcus. The former differs from *D. parvicostata* in having less slope of the cardinal area and finer surface ornamentation. The latter differs by its much greater width-length ratio.

Occurrence.—Rare to abundant in the Ames and Skelley units and questionably present in the Brush Creek unit.

Type locality.—The Ames limestone and shale at locality Go-1. The species is associated with numerous specimens of *Neospirifer dunbari*, *Linoproductus platyumbonus*, *Juresania nebrascensis*, *Composita subtilita*, *Neochonetes granulifer*, *Punctospirifer kentuckyensis* var. *amesi*, and crinoid plates and columns.

Repository.—Holotype, OSU-27061; paratypes, OSU-27062, 27063.

Derbyia cf. *D. plattsmouthensis* Dunbar & Condra

Pl. 3, figs. 13, 14

Orthis umbraculum Owen, 1852, pl. 5, fig. 11.

Derbyia plattsmouthensis Dunbar & Condra, 1932, p. 106, 107, pl. 11, figs. 1-4.

Shell of medium size, with greatest width at mid-length and distinctly wider than long. Brachial valve with small beak; moderately convex, highest posterior to mid-length; median area flattened; and posterolateral areas slightly concave. Pedicle valve with cardinal area less than one-sixth as high as long; deltidium forming angle of about 53° ; perideltidial area forming angle of about 125° ; probably with a low, convex shape; and cardinal extremities obtusely angular. Surface of valves parvicostellate; costae and costellae very narrow and uniform with concave sides and numbering 26-27 per cm at a distance of 1 cm from beak; and interspaces wider than costae and costellae. Concentric, fine, lirae growth lines conspicuous in interspaces and on costae and costellae.

Internal features not observed. A nearly complete, but slightly distorted, specimen is 30.8 mm long and 39.7 mm wide.

Discussion.—The specimens described above compare favorably with *Derbyia plattsmouthensis* in most of the features observable. The width-length ratio is somewhat greater than in the specimens described by Dunbar and Condra (1932) and the perideltidial angle is smaller than noted in the specimens from the Western Interior basin.

Occurrence.—Rare in the Portersville unit.

Repository.—Hypotype, OSU-27064.

Derbyia cf. *D. crassa* var. *subcircularis*

Dunbar & Condra

Pl. 3, figs. 15-18

Derbyia crassa var. *subcircularis* Dunbar & Condra, 1932, p. 84, pl. 4, figs. 1a, b.

Shell small to medium with greatest width anterior to mid-length and nearly equal in width and length. Brachial valve with obsolescent interarea; beak low;

surface gently convex; and greatest height posterior to mid-length. Pedicle valve with relatively high cardinal area, approximately one-third as high as wide; deltoidal angle of 42° ; perideltoidal angle of 93° ; surface irregularly convex; and beak small, in some cases deformed. Surface parvicostellate, similar to surface of the species but with 23-25 costae and costellae per cm at a distance of 1 cm from beak.

Average dimensions of two specimens are: length, 19.7 mm, and width, 20.5 mm.

Discussion.—The specimens described above agree closely with those described by Dunbar and Condra (1932) except that fasciculation of the surface ornamentation is somewhat more pronounced in the former. The fine, concentric ornamentation is also more strongly developed than on the type specimens.

Occurrence.—Rare in the Washingtonville and Columbiana units and questionably present in the Tuscarawas unit.

Repository.—Hypotypes, OSU-27065, 27066.

Derbyia sp.

Pl. 3, fig. 19

Derbya robusta Morningstar, 1922, p. 177, 178, pl. 7, fig. 11.

Shell large, with greatest width near mid-length. Brachial valve rather strongly convex. Brachial interior with a strong cardinal process divided by a median groove; supporting plates heavy, diverging at an angle greater than 90° , then curving anteriorly and extending a considerable distance out into the valve; sockets large, rounded; and median septum and muscle scars not apparent. Pedicle valve and external ornamentation not observed.

One specimen, an internal mold, measures 51.5 mm in length and 66.2 mm in width.

Discussion.—Morningstar (1922) originally designated this specimen as *Derbya robusta* (Hall), primarily on the basis of its size. There is no indication of the type of external ornamentation, which is in part diagnostic of *D. robusta*, nor is the specimen complete enough to make an accurate comparison. The hinge line, as noted by Morningstar, is much less than the greatest width of the shell, which is not true in the case of *D. robusta*. This may be caused in part by the distortion of the specimen. A few fragments of a large *Derbyia* occur in the Putnam Hill unit and show an ornamentation which may be like that of *D. robusta*, but valid comparisons are impossible with the material available. Mark (1912) also reported *D. robusta* from the Ames but did not describe or figure it.

Occurrence.—Reported as rare to common in the Lower Mercer unit by Morningstar (1922).

Repository.—Hypotype, OSU-15224.

Genus *Rugosochonetes* Sokolskaya, 1950

Rugosochonetes delicatus n. sp.

Pl. 4, figs. 16-30

Chonetes choteauensis Morningstar, 1922, p. 178, 179, pl. 7, figs. 16-18.

Shell small, flatly convex, with greatest width at hinge line or between hinge line and mid-length. Pedicle valve with lateral margins subparallel, rounding smoothly into straight to convex anterior margin; surface smoothly convex or with very shallow, broad sulcus; ornamentation multicostellate with numerous lamellose growth lines crossed by subangular to rounded and widely spaced costae and costellae numbering 5-6 per mm along anterior margin; spinule bases abundant; and up to seven spines present on each side of beak and diverging from hinge line at an angle of 49° . Brachial valve with ornamentation as on pedicle valve, and reflexed interarea.

Brachial interior with a low cardinal process, bilobate internally, tetralobate externally; chilidial plates present; alveolus small, shallow; outer socket ridges present; inner socket ridges weak; a pair of lateral septa diverging from region of alveolus at an angle of 52° ; median septum weakly developed, consisting of a row of enlarged endospines or a low, rounded ridge extending to near mid-length of valve; muscle scars not impressed; brachial ridges not developed; and radiating rows of endospines, not fused into ridges, covering shell surface except for posterolateral regions.

Pedicle interior with a pseudodeltidium; a callus partially filling delthyrium in some cases; median septum a high, thin blade posteriorly, continuing as a low, rounded ridge to near mid-length; muscle scars not strongly impressed, although outer ridge is evident in some specimens; vascular trunks of enlarged endospines, in some cases fused, present in many specimens; teeth small, not elongated; and endospines in radiating rows covering surface except for muscle scar regions.

Discussion.—*Rugosochonetes delicatus* may be confused with species of *Neochonetes* but can be differentiated by internal characters and by hinge spines, which are at a greater angle to the hinge line in *Rugosochonetes*. Results of statistical analyses on *Rugosochonetes* and other chonetid brachiopods are given in table 4.

Occurrence.—Abundant in the Lowellville, Boggs, and Lower Mercer units.

Type locality.—The Boggs shale at locality Tfr-1. The species is associated with *Mesolobus obsoletus*, *Hustedia miseri*?, *Composita subtilita*, *Anthracospirifer occiduus*, *A. rockymontanus*, *Rhipidomella carbonaria*, *Derbyia crassa*, *Derbyia* sp., *Antiquatonia costellata*, *A. portlockiana* var. *quadrata*, *Desmoinesia muricatina*, *Linoproductus planiventralis*?, and *Lino-*

TABLE 4.—Statistical characterization of samples of chonetid brachiopods

Species	Locality	Measurements (mm) ¹										
		N	\bar{L}	\bar{W}	\bar{H}	s_l	s_w	s_h	r_{wl}	r_{wh}	OR _w	D _{wl}
<i>N. semiacanthus</i>	Lu-1	50	8.17	12.97	2.45	1.19	1.80	.528	.811	.652	9.0-17.0	8.40
<i>N. granulifer</i>	CAC-2	50	9.79	16.62	3.13	1.76	2.28	.808	.858	.675	10.0-20.4	7.94
<i>N. granulifer</i>	A ²	49	10.04	17.20	2.57	1.37	2.37	.583	.815	.420	10.9-22.8	8.25
<i>C. flemingi</i>	Ls-1	50	8.14	14.10	3.13	.408	1.55	.252	.708	.353	8.4-17.0	7.55
<i>C. alata</i>	Pmo-2	50	8.14	13.23	2.45	1.14	1.71	.563	.839	.767	8.7-16.0	7.48
<i>C. plebeia</i>	At-9	44	5.80	9.56	1.73	1.09	1.62	.462	.813	.869	7.1-13.2	9.01
<i>M. striatus</i>	Vel-11	50	7.67	12.81	2.68	.697	1.31	.475	.522	.364	10.1-16.4	9.72
<i>M. striatus</i>	Vel-12	50	8.60	13.80	2.68	.273	1.18	.146	.743	.498	11.4-16.8	5.33
<i>M. striatus</i>	Hfg-5	50	7.07	11.36	2.26	.681	1.16	.385	.794	.118	9.0-13.8	6.45
<i>M. mesolobus</i>	B ³	50	7.15	10.78	2.71	.717	1.07	.344	.809	.579	8.2-13.5	6.19
<i>M. mesolobus</i>	C ⁴	41	6.82	10.41	2.06	.839	1.40	.391	.924	.375	7.8-13.8	5.11
<i>M. mesolobus</i>	Vs-3	50	6.68	10.57	1.78	.845	1.43	.412	.937	.666	7.3-13.5	4.75
<i>M. lioderma</i>	Cp-3	50	5.36	8.91	2.01	.476	.780	.203	.702	.355	6.8-10.6	6.87
<i>M. obsoletus</i>	MUwy-1	23	6.16	9.13	2.26	.834	1.06	.321	.849	.667	7.0-10.4	6.73
<i>R. delicatus</i>	Tfr-1	50	8.39	12.89	1.86	1.27	1.87	.448	.971	.831	9.2-17.0	3.59
<i>P. dotus</i>	Vel-6	50	5.56	7.82	2.25	.769	1.21	.463	.699	.807	4.3-9.9	11.59
<i>E. fragilis</i>	MUwa-4	50	6.52	9.85	1.36	.903	1.38	.313	.991	.836	7.6-12.5	1.87
<i>E. bilobatus</i>	D ⁵	41	8.20	13.38	2.31	.980	1.93	.545	.753	.620	8.4-16.9	3.00
<i>E. keyesi</i>	E ⁶	21	9.29	13.91	2.05	1.22	1.72	.463	.910	.898	10.4-17.9	5.35

1. N Number of specimens in sample

 \bar{L} Mean length \bar{W} Mean width \bar{H} Mean height s_l Standard deviation of length s_w Standard deviation of width s_h Standard deviation of height r_{wl} Coefficient of correlation of width and length r_{wh} Coefficient of correlation of width and heightOR_w Observed range of widthD_{wl} Coefficient of relative dispersion of width and length measurements around the reduced major axis2. SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 7, T. 48 N., R. 26 W., Lafayette County, Missouri. Mine Creek Shale Member.

3. Sec. 33, T. 5 N., R. 8 E., Hughes County, Oklahoma. Wewoka Formation.

4. SW $\frac{1}{4}$ sec. 4, T. 2 S., R. 7 W., St. Clair County, Illinois. Carbondale Formation (Brereton).5. E $\frac{1}{2}$ sec. 36, T. 43 N., R. 27 W., Henry County, Missouri. Shale under the Tiawah Limestone.6. SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, T. 38 N., R. 31 W., Vernon County, Missouri. Robinson Branch Formation.

productus sp.

Repository.—Holotype, OSU-25966; paratypes, OSU-25959 to 25965, 25967 to 25971.

Genus *Eolissochonetes* Hoare, 1960

Eolissochonetes fragilis n. sp.

Pl. 5, figs. 19-30

Shell small, with greatest width at hinge line or between hinge line and mid-length. Pedicle valve with cardinal extremities commonly slightly produced; lateral margins straight and parallel to somewhat concave and converging towards anterior margin, into which they round smoothly; anterior margin straight to slightly convex, but not sinuate; convexity of valve low; beak small, umbo not inflated; surface ornamentation of numerous fine growth lines and abundant spinule bases; and up to seven spines present on each side of beak, spines diverging from hinge line at an angle of 46° . Brachial valve with low concavity; ornamentation as on pedicle valve; and interarea slightly reflexed.

Brachial interior with a long, low, narrow median septum extending well over three-fourths of valve length; septum may be a row of enlarged and partially fused endospines; a pair of small lateral septa diverging from region in front of alveolus at an angle of 49° ; inner socket ridges heavy; outer socket ridges not developed; muscle scar areas commonly not impressed; brachial ridges weak to strongly developed, the latter in gerontic individuals; cardinal process of medium height, internally bilobate, externally tetralobate; small chilidial plates present; and surface covered with endospines except for the posterolateral regions and the muscle scar regions, endospines partially fused where the brachial ridges are more strongly developed.

Pedicle interior with a short, high, thin median septum which continues anteriorly as a low, rounded ridge to about mid-length; vascular trunks not developed, although one specimen shows a pair of parallel ridges in the posterior region; muscle scars not impressed; teeth short; pseudodeltidium small; and inner surface covered, except for muscle scar areas, with radially arranged endospines of nearly uniform size.

Discussion.—*Eolissochonetes fragilis* might be confused with *Mesolobus mesolobus* in some instances since, in the former, the brachial median septum may be punched into the pedicle valve during compaction, giving a false median lobe. *E. fragilis* is easily distinguished by its internal features and by lack of lobation of the brachial valve. *E. keyesi* Muir-Wood (= *Chonetes laevis* Keyes, preoccupied) is consistently larger than *E. fragilis* and has a more pronounced brachial median septum and pedicle vascular trunk. *E. keyesi* does have chilidial plates which were not reported by Hoare (1960). *E. bilobatus* Hoare has a pedicle sulcus and a greater convexity, more pronounced vascular

trunks, and larger median septum than does *E. fragilis*.

Occurrence.—Abundant in the Washingtonville unit; common in the Dorr Run unit; rare in the Columbiana unit; and questionably present in the Tuscarawas unit.

Type locality.—The Washingtonville shale at locality MUwa-4. The species is associated with *Mesolobus mesolobus* and *Linoproductus echinatus*?

Repository.—Holotype, OSU-25903; paratypes, OSU-25900 to 25902, 25904 to 25910.

Genus *Mesolobus* Dunbar & Condra, 1932

One of the more vexing problems, taxonomically, within the study of the chonetids has been the status of the genus *Mesolobus* and its type species *Chonetes mesolobus* Norwood & Pratten. Since the type specimens were lost and comparison of faunas with them became impossible there has been much written as to which form of this genus was actually used for description by the original authors. Whether or not the forms were multicostellate will not be discussed here as the subject has been amply covered by others (Dunbar and Condra, 1932; Weller and McGehee, 1933; Hoare, 1960, 1961).

The major problem appears to be recognition of the form described by Norwood and Pratten. Weller and McGehee (1933) selected the variety *lioderma* Dunbar & Condra as the representative form of *Mesolobus mesolobus* s.s. Girty (1915a) on the other hand, states that the variety *deciapiens* Girty "has the characteristic configuration of *C. mesolobus*, but the surface is entirely without radiating sculpture . . ."

A comparison of Girty's type specimens of *Chonetes mesolobus* var. *deciapiens* from Oklahoma (pl. 6, figs. 1-6), Dunbar and Condra's type specimens of *M. mesolobus* var. *lioderma* from Oklahoma, Missouri, and Iowa (pl. 6, figs. 25-34), specimens from sixteen other collections from the Wewoka Formation and Wetumka Shale of Oklahoma, and from eight collections from the Pennsylvanian in and around Belleville, Illinois, with Norwood and Pratten's (1855a) illustrations leads the authors to believe that Girty's variety *deciapiens* comes closest to the form described by Norwood and Pratten. The form *lioderma* has a greater transverse shape, is more strongly convex, and has deeper lobation beginning closer to the beak than is indicated by Norwood and Pratten's figures.

An application has been made to the ICZN to recognize the specimen illustrated herein on plate 6, figures 7-9, as the neotype of *Chonetes mesolobus* Norwood & Pratten, the type species of *Mesolobus* (Hoare, 1964). This application has been approved (ICZN opinion 797, 1966). This specimen, those illustrated on plate 6, figures 10-16, and 57 other specimens are in a collection made by L. G. Henbest in 1927 from the shale between the coal No. 6 caprock and limestone in the Solar Coal Company strip pit, SW $\frac{1}{4}$ sec. 4, T. 2 S., R. 7 W., St. Clair County, Illinois, which be-

comes the type locality for this species. The collection is in the repository of the Illinois Geological Survey, No. IGS 34P.

Mesolobus lioderma Dunbar & Condra and *M. euampygus* (Girty) are herein raised to specific rank in that they are recognizably distinct forms on the basis of modern classification. The specimens illustrated on plate 20, figures 17-22, by Dunbar and Condra (1932) and identified as *M. lioderma* from the Boggy Formation of Oklahoma are not specimens of *Mesolobus* and should be assigned to another genus, probably *Rugosochonetes*.

Mesolobus mesolobus (Norwood & Pratten)

Pl. 6, figs. 1-24

Chonetes mesolobus Norwood & Pratten, 1855, p. 27, pl. 11, figs. 7a-c; Girty, 1899, p. 576; ---, 1903, p. 357, pl. 1, figs. 20-23; [non] Morn-ingstar, 1922, p. 179, 180, pl. 7, figs. 10, 11.

Chonetes mesolobus var. *decipiens* Girty, 1911, p. 127; ---, 1915, p. 62-64, pl. 7, figs. 5-7a.

Mesolobus mesolobus var. *decipiens* Dunbar & Condra, 1932, p. 165-167, pl. 20, figs. 13-16, [non] figs. 17-22; Hoare, 1960, pl. 31, figs. 5, 6; ---, 1961, p. 42-44, pl. 2, figs. 14-18.

Mesolobus mesolobus Muir-Wood (in Moore, 1965), p. 430, figs. 285, 3a-d; 286, 4a.

Shell small, with greatest width at hinge line or near mid-length. Pedicle valve with lateral margins nearly parallel, rounding smoothly into slightly sinuate anterior margin; valve gently convex with flat to slightly concave lateral slopes and flattened in area of umbo; median sulcus and lobe not distinct until mid-length in many specimens; sulcus not deep, lobe not strong; surface ornamentation of growth lines and spinule bases; and up to seven spines on each side of the beak, diverging from hinge line at an angle of 32°. Brachial valve flat to gently concave; median fold not pronounced; median sulcus shallow; and interarea reflexed.

Brachial interior with a low cardinal process, bilobate internally, tetralobate externally; chilidial plates present; sockets narrow with no outer ridges and relatively weak inner ridges paralleling hinge line; alveolus present; a pair of small lateral septa diverging from area in front of alveolus; median septum beginning in front of alveolus as a low, rounded ridge becoming highest anterior to mid-length and continuing to within 1 mm of anterior margin, anterior portion of septum may be spinose; muscle scars slightly impressed; brachial ridges moderately developed; and endospines covering surface except for muscle scar areas and posterolateral regions, endospines partially fused into ridges in elevated brachial ridge areas.

Pedicle interior with a thin median septum, high posteriorly, extending half valve length as a low,

rounded ridge; vascular trunks developed on internal ridges formed by median sulcus and lobe in older specimens; diductor scars large, not impressed; adductor scars may be raised; teeth small, short; and surface covered by radially arranged endospines except for muscle scar areas.

Discussion.—Based upon the discussion of the genus *Mesolobus*, *Mesolobus mesolobus* has the form of *Mesolobus mesolobus* var. *decipiens* (Girty). The specimens described above differ from *M. lioderma* Dunbar & Condra in that they are not as strongly lobate and they have the median sulcus beginning further from the beak than does the latter species. The lateral slopes from the ridges bordering the median sulcus are much steeper and the ridges diverge at a greater angle in *M. lioderma* than in *M. mesolobus*. *M. euampygus* (Girty) is not represented in the Ohio collections but examination of the type specimens from the Wewoka Formation in Oklahoma shows a greater convexity at the same growth size, much stronger lobation with steep and strongly concave lateral slopes characteristic of the ridges bordering the median sulcus, and a narrower median lobe than in *M. mesolobus*. *M. obsoletus* n. sp. differs from *M. mesolobus* in having partially multicostellate valves.

Occurrence.—Abundant in the Vanport unit; common in the Columbiana and Washingtonville units; and questionably present in the Putnam Hill unit.

Repository.—Neotype, IGS 34P-1; hypotypes, IGS 34P-2 to 6, OSU-25911 to 25916.

Mesolobus lioderma Dunbar & Condra

Pl. 6, figs. 25-34; pl. 7, figs. 1-9

Mesolobus mesolobus var. *lioderma* Dunbar & Condra, 1932, p. 164, 165, pl. 20, figs. 3-12; Hoare, 1960, pl. 31, figs. 1, 2; ---, 1961, p. 45, 46, pl. 3, figs. 1-4; Muir-Wood, 1962, p. 80, pl. 9, figs. 2-4, 7, 8.

(?) *Mesolobus mesolobus* Stevens, 1962, pl. 93, figs. 4-6.

Shell small, with greatest width at hinge line. Pedicle valve with lateral margins nearly parallel, rounding smoothly into sinuate anterior margin; median fold pronounced, slightly lower than lateral humps; lateral area gently convex to slightly concave; up to seven spines present on each side of beak, diverging from the hinge line at an angle of 27°; and surface ornamentation of growth lines and spinule bases. Brachial valve concave; median sulcus bordered by sharp, distinct ridges; and interarea reflexed.

Brachial interior with a small, slightly elevated cardinal process, bilobate internally, tetralobate externally, bounded by large chilidial plates; sockets narrow, lacking outer ridges, inner ridges extending along hinge line; alveolus small; a pair of small lateral septa, diverging at an angle of 55°, given off from inner socket ridges and not fused with median septum;

median septum a low, rounded ridge in front of alveolus, increasing in height anteriorly before terminating sharply at four-fifths of valve length, anterior portion of septum commonly spinose; muscle scars not deeply impressed; brachial ridges raised, strongly developed; and inner surface, except for the posterolateral regions, covered with endospines which are enlarged and may be fused in radial ridges in the raised brachial ridge regions.

Pedicle interior with small pseudodeltidium; teeth small, short; median septum high, bladlike posteriorly, continuing as a low, rounded ridge past mid-length; adductor scars narrow, elongate, impressed; diductor scars small, raised in some cases; the pair of ridges formed by the median sulcus and fold appearing to serve as vascular trunks; endospines on these ridges not enlarged or fused; and inner surface, except for muscle scar areas, bearing radial rows of endospines.

Discussion.—*Mesolobus lioderma* is readily distinguished from *M. mesolobus* (Norwood & Pratten), as discussed under the latter species. The specimens of *M. lioderma* in the Pennsylvanian of Ohio are commonly a little smaller than the types from Iowa and Missouri. Except for this difference, many specimens in the Ohio collections could substitute completely for the type specimens. *M. euampygus* (Girty) is normally smaller in size than *M. lioderma* but not consistently so. At first appearance the specimen illustrated by Dunbar and Condra (1932, pl. 20, fig. 10) as var. *lioderma* is the same as the specimen figured by Girty (1915a, pl. 7, fig. 8) as intermediate between *euampygus* and *decipiens*. Closer inspection of the specimens shows a more pronounced convexity of the umbonal area with a much stronger concavity of the lateral slopes of *M. euampygus* than is the case for *M. lioderma*. Commonly the middle lobe of *M. euampygus* is very narrow and equal lobation of the three lobes is not consistently present.

Occurrence.—Abundant in the Columbiana and Washingtonville units and questionably present in the Vanport unit.

Repository.—Hypotypes, OSU-25917 to 25923.

Mesolobus obsoletus n. sp.

Pl. 7, figs. 10-19

Shell small, with greatest width at hinge line or between hinge line and mid-length. Pedicle valve moderately to strongly convex; prominent median sulcus beginning 1.5-2.0 mm from beak, containing a large, broadly rounded median lobe; lateral margins slightly concave; numerous growth lines present, more prominent anteriorly; ornamentation multicostellate with low, obsolescent costae and costellae more conspicuous on the anterior portion of the valves, although they may be evident over the entire shell; costae and costellae, bearing numerous spinule bases, number 6-7 per mm along ventral margin; and up to six spines present

on each side of beak, diverging from hinge line at an angle of 26° . Brachial valve with two prominent ridges and intervening median sulcus; ornamentation as on pedicle valve; and interarea reflexed.

Brachial interior with a low cardinal process, bilobate internally, tetralobate externally; chilidial plates present; alveolus large, distinct; sockets small with heavy internal ridges; median septum broad posteriorly, becoming much higher anteriorly, continuing four-fifths of the valve length; a pair of lateral septa diverging at an angle of 55° from the inner edge of the socket ridges; adductor scars deeply impressed; brachial ridges strongly developed; and endospines covering surface, except for posterolateral areas, and fused into ridges in brachial ridge area.

Pedicle interior with a pseudodeltidium and heavy callus, which, combined, completely fill delthyrium in some specimens; teeth short, heavy; median septum a thin, high blade posteriorly, continuing as a prominent ridge to near mid-length; outer border of diductor scars well developed; adductor scars impressed; vascular trunks present, formed from endospines, in some specimens partially fused into a ridge; and endospines covering interior surface except for muscle scar areas.

Discussion.—The most distinguishing characteristic of *Mesolobus obsoletus* is the obsolescent costae and costellae. The species also differs from *M. euampygus* by having a broader median lobe and less distinct lateral ridges bordering the median sulcus. *M. lioderma* is less convex than *M. obsoletus* and the median sulcus begins much nearer the beak, with the median lobe being narrower. The lobation is much stronger in *M. obsoletus* than in *M. mesolobus*. *M. striatus* has larger and fewer costae and costellae per mm than *M. obsoletus* and the shell is less convex and less strongly lobed.

Occurrence.—Abundant in the Columbiana, Vanport, and Putnam Hill units and common in the Boggs and Lower Mercer units.

Type locality.—The Vanport limestone and shale at locality MUho-4. The species is associated with specimens of *Reticulatia rugatita*, *Echinaria semipunctata* var. *knighti*, *Linoproductus* sp., and *Composita* sp.

Repository.—Holotype, OSU-25928; paratypes, OSU-25924 to 25927, 25929, 25930.

Mesolobus striatus Weller & McGehee

Pl. 4, figs. 1-5; pl. 7, figs. 20-37

Chonetes mesolobus Girty, 1915, pl. 7, figs. 10, 11; Morningstar, 1922, p. 179, 180, pl. 7, figs. 14, 15.

Mesolobus mesolobus Dunbar & Condra, 1932, p. 161-164, pl. 20, figs. 2a, b, [non] fig. 1.

Mesolobus striatus Weller & McGehee, 1933, p. 109, 110; Hoare, 1960, p. 222, 223, pl. 31, figs. 7-11; —, 1961, p. 46-49, pl. 3, figs. 9-14;

Stevens, 1962, pl. 93, figs. 7, 8; Muir-Wood, 1962, p. 79-81.

Shell small, with greatest width at hinge line where lateral extremities are generally produced. Pedicle valve with lateral margins slightly concave anterior to hinge line, rounding smoothly into slightly sinuate anterior margin; beak small, umbo not greatly inflated; moderately convex; sulcus deep to shallow, median lobe strong to very weak; rather coarse costae and costellae numbering 4-6 per mm, forming multicostellate ornamentation; costae and costellae on median sulcus and lobe generally somewhat smaller and more numerous than on lateral areas; spinule bases numerous; up to nine spines, present on each side of beak, diverging from the hinge line at an angle of 43° ; and pseudodeltidium generally small but filling as much as one-half of delthyrium in some cases. Brachial valve concave; ornamentation as on pedicle valve; and interarea reflexed.

Brachial interior with a low cardinal process, bilobate internally, tetralobate externally; distinct chilidium; sockets large, having moderately strong inner ridges, lacking outer ridges; alveolus small; distinct median septum anterior to alveolus, continuing to near mid-length as a low, rounded ridge, then abruptly becoming much higher, with greatest height just anterior to mid-length, and diminishing in height abruptly and terminating just before reaching anterior margin; top of septum at greatest height and anterior to this point commonly spinose; a pair of thin, low lateral septa diverging at an angle of 81° in front of alveolus and then extending into the brachial ridges, which are prominent on mature specimens; adductor and diductor scars distinct, somewhat impressed; and, endospines covering surface except for muscle scar areas and area along posterior margin, papillose along the marginal areas and fused into ridges in the area of the brachial ridges in some specimens.

Pedicle interior with short, heavy teeth; a high, thin median septum under beak becoming a low, rounded ridge extending to about mid-length of valve; vascular trunks moderately developed; muscle scars not deeply impressed but discernable, with outer ridge evident but not prominent; and radially arranged endospines covering surface except for muscle scar areas.

Discussion.—The specimens described by Hoare (1960, 1961) from the Burgner Formation and the Seville Limestone in Missouri agree closely with those described above except for the statement in the description of the Missouri specimens that 8-11 "straie" occur in 1 mm. A check of the specimens from that area show this to be an error on the part of the author and that 4-6 costae and costellae per mm are present on those specimens.

Stevens (1962) described *M. striatus* from the Minturn Formation of Colorado and the description agrees closely with those of both the Missouri and Ohio speci-

mens. He also illustrates multicostellate *Mesolobus* lacking the median lobe but with a node, formed by punching through of the median septum, in the median sulcus. A few specimens in several Ohio collections also lack the median lobe and this appears to be a minor variation as no large population having this characteristic was found. These specimens are still included in *M. striatus* and Steven's specimens should probably be included in *M. depressus* Stevens, which is also a multicostellate form. The latter species is described as more quadrate and less convex than *M. striatus*, and with less evenly rounded lateral lobes. It comes from the same unit in the Minturn Formation as *M. striatus* and may be an older growth state of that form. *M. indistinctus* Stevens is also multicostellate but the lobation of the shell is much weaker than that of *M. striatus*. *M. mesolobus* var. *inflexus* (Girty) may be a synonym of *M. striatus*, as suggested by Muir-Wood (1962).

Specimens of *M. striatus* from the Putnam Hill limestone and shale and from the Vanport limestone agree closely with those from the Lower Mercer and Upper Mercer limestones. The number of costae, costellae, and spines, and the lobation and internal features are similar. In some Putnam Hill collections the average size is greater, with the number of spines increasing to eleven pairs on a few specimens and with as many as 7 costae and costellae per mm on a few specimens.

In a number of collections from the Lower Mercer, where the unit is black and argillaceous, specimens of *M. striatus* are small, thin-shelled, weakly convex, and lobate, with a relatively low brachial median septum, and with costae and costellae more weakly developed and in some cases nearly obsolete. In several collections from the Putnam Hill limestone and shale *M. striatus* populations include a number of specimens which are larger, less strongly multicostellate, less convex, and more weakly lobate than is normal for this species. Internally features are much the same as in more typical specimens, although more suppressed than common, especially the brachial median septum, which is low and not spinose. These specimens intergrade with normal specimens of *M. striatus* and appear to be nothing more than a large variation in a normal population.

Occurrence.—Abundant in the Lower Mercer, Upper Mercer, Putnam Hill, and Vanport units. Also reported from the Boggs unit by Morningstar (1922).

Repository.—Hypotypes, OSU-25931 to 25949.

Genus *Plicochonetes* Paeckelmann, 1930

Plicochonetes dotus n. sp.

Pl. 4, figs. 6-15

Shell small and strongly convex, with greatest width at hinge line. Pedicle valve with lateral margins converging anteriorly and rounding smoothly into gently convex anterior margin; median area of pedicle valve flattened, sloping abruptly into lateral regions, which

are strongly concave; surface multicostellate, with 5-6 costae and costellae per mm along anterior margin; up to five spines present on each side of the beak, diverging from hinge line at an angle of 63° ; growth lines not prominent; and spinule bases common. Brachial valve slightly concave and ornamentation as on pedicle valve.

Brachial interior with a cardinal process internally and externally tetralobate; chilidial plates present; inner socket ridges strong, short, not extending parallel to hinge line; alveolus large; a pair of narrow lateral septa diverging from region of alveolus at an angle of 61° ; median septum short, strong, beginning near anterior end of lateral septa and extending to slightly beyond mid-length of valve; septum commonly spinose at anterior end and uneven in height and width; brachial ridges moderately developed, in some cases outlined by enlarged endospines which may be partially fused into ridges; muscle scars not impressed; and endospines moderately developed on anterior portion of valve and along lateral margins, with extreme margin papillose.

Pedicle interior with a small pseudodeltidium. Other internal features not observed.

Discussion.—This is the only species of *Plicochonetes* found in the Pennsylvanian section of Ohio and it is easily distinguished from other chonetids in this section by a low width-length ratio, by the strong convexity of the pedicle valve, by the large angle which the spines make with the hinge line, and by the small size. "*Chonetes*" *arkansanus* Mather (1915), described from the Morrow Group of Arkansas, may belong to *Plicochonetes* and approaches *P. dotus* more closely than any other form. "*C.*" *arkansanus* differs in being consistently larger, in having the greatest convexity posterior to mid-length, and in having finer costae and costellae. Mather did not describe the internal features of his species. *P. dotus* differs from "*Chonetes*" *ornatus* Shumard and *Plicochonetes glenparkensis* (Weller) by being more finely multicostellate. Muir-Wood (1962) gives Devonian and Lower Carboniferous as the geologic range of *Plicochonetes* and its presence in the Lower Mercer shale extends this range to the lower beds of the Upper Carboniferous.

Occurrence.—Found only in the shale under the Lower Mercer limestone, where it is abundant.

Type locality.—The Lower Mercer shale at locality Vel-6. The species is associated with *Rugosochonetes delicatus*, *Hustedia miseri*, *Cleiothyridina orbicularis*, *Punctospirifer kentuckyensis*, *Anthracospirifer occiduus*, *A. rockymontanus*?, *Rhipidomella carbonaria*, *Schizophoria resupinoides*?, *Derbyia crassa*, *Orbiculoida missouriensis*, *Antiquatonia costellata*, *Krotovia paucispina*, *Desmoinesia muricatina* var. *missouriensis*, *Echinaria* sp., *Juresania nebrascensis*, *Linoproductus planiventralis*, and *Linoproductus* sp.

Repository.—Holotype, OSU-25950; paratypes, OSU-25951 to 25958.

Genus *Chonetinella* Ramsbottom, 1952
Chonetinella flemingi (Norwood & Pratten)
Pl. 5, figs. 1-4; pl. 8, figs. 16-21

Chonetes flemingi Norwood & Pratten, 1855, p. 26, pl. 2, figs. 5a-e; Hall & Clarke, 1892, pl. 15-B, fig. 11.

Chonetina flemingi Dunbar & Condra, 1932, p. 151-154, pl. 19, figs. 18-28.

Chonetinella flemingi Muir-Wood, 1962, p. 85, 86, pl. 9, figs. 10-17; — (in Moore, 1965), p. 430, 431, figs. 288, 1a-f.

Shell small, with greatest width at the hinge line where lateral extremities are generally produced. Pedicle valve with lateral margins concave anterior to hinge line, converging anteriorly, and rounding into sinuous anterior margin; beak small; sulcus deep, relatively narrow, bordered by a pair of slightly diverging lateral ridges which broaden anteriorly; lateral slopes of the ridges prominent anteriorly; surface multicostellate, 5 costae and costellae per mm; six to seven pairs of spines diverging from hinge line at an angle of 31° ; and spinule bases present. Brachial valve with distinct fold corresponding to pedicle sulcus; ornamentation as on pedicle valve; and interarea reflexed.

Brachial interior with a prominent cardinal process, bilobed internally, tetralobed externally; shallow, broad alveolus located at base of process in area of convergence of weakly developed inner socket ridges; short lateral septa diverging at an angle of 55° ; low median septum extending just past mid-length, slightly higher anteriorly, where several endospines are commonly fused to the septum; small outer socket ridges; brachial ridges conspicuous on some individuals; and radial rows of endospines well developed on anterior half of valve.

Pedicle interior with elongated teeth; a high median septum beginning under beak and extending anteriorly as a low, rounded ridge terminating near mid-length of valve; prominent vascular trunk present in some specimens; large diductor scars strongly to weakly impressed or on raised platforms; and endospines common, more prominent near margins of valve.

Discussion.—*Chonetinella flemingi*, in these collections, differs from *C. verneuliana* (Norwood & Pratten) by being larger and by having a less transverse outline, a smaller relative depth of the pedicle valve and sulcus, and a more pronounced concavity of the lateral slopes of the ridges bordering the sulcus. Both *C. alata* (Dunbar & Condra) and *C. plebeia* (Dunbar & Condra) are less convex forms than *C. flemingi* and have less pronounced sulci.

Occurrence.—Abundant in the Cambridge and Portersville units.

Repository.—Hypotypes, OSU-25880 to 25887.

Chonetinella alata (Dunbar & Condra)
Pl. 8, figs. 7-15

Chonetes verneulianus Mark, 1912, p. 301, 302, pl. 13, figs. 4, 5.

Chonetina flemingi var. *alata* Dunbar & Condra, 1932, p. 154, 155, pl. 19, figs. 29-36.

Chonetinella flemingi var. *alata* Muir-Wood, 1962, p. 85, 86.

Shell small, with greatest width at hinge line. Pedicle valve with lateral extremities right angled to slightly extended; beak small; valve moderately convex; lateral margins converging anteriorly, rounding into slightly sinuous anterior margin; median sulcus shallow, becoming broader near anterior margin; bordering ridges not prominent; up to six pairs of spines diverging from hinge line at an angle of 22° ; surface multicostellate, 5 costae and costellae per mm; spinule bases present; and growth lines prominent. Brachial valve with low median fold; ornamentation as on pedicle valve; and interarea reflexed.

Brachial interior similar, in general, to that of *C. flemingi*; cardinal process in *C. alata* broader and shorter than in *C. flemingi* and brachial ridges more pronounced in the latter species; areas bordering median septum not as sulcate in *C. alata* as in *C. flemingi* because of the more pronounced brachial fold in the latter species; outer socket ridges lightly developed as in *C. flemingi*; and short lateral septa diverging at an angle of 51° .

Pedicle interior with high median septum under beak, becoming a low, rounded ridge extending past mid-length of valve; prominent, heavy vascular trunks present in gerontic shells; large, flabellate diductor scars, moderately impressed, in many cases showing a low, rounded ridge running through central portion of scars; smaller adductor scars generally not impressed, although on raised platforms in gerontic individuals; pseudodeltidium small, filling half of delthyrium in some cases; teeth elongate; and endospines common, becoming more prominent and papillose near anterior margin.

Discussion.—Specimens of *Chonetinella alata* in these collections are easily distinguished from those of *C. flemingi* on the basis of general shell shape and the nature of the median sulcus and fold. Internal differences in the brachial valve are noted above. These *C. alata* specimens agree very closely with those described by Dunbar and Condra (1932) from the Weston Shale (Upper Missourian) in Kansas except that they have a smaller average size, which accounts for the fewer spines along the hinge line.

Occurrence.—Abundant in the Portersville unit and rare in the Ames unit.

Repository.—Hypotypes, OSU-25872 to 25879.

Chonetinella plebeia (Dunbar & Condra)
Pl. 5, figs. 8-18

Chonetina flemingi var. *plebeia* Dunbar & Condra, 1932, p. 156, 157, pl. 19, figs. 4, 8-13.

Chonetinella flemingi var. *plebeia* Muir-Wood, 1962, p. 86.

Shell small, with greatest width at hinge line. Pedicle valve with cardinal extremities right angled to slightly produced; lateral margins converging toward, and rounding smoothly into, slightly sinuate anterior margin; beak small; median sulcus shallow, not noticeable until mid-length in some specimens, although commonly beginning within 2 mm of beak; areas bordering sulcus with gentle slopes, not sharply defined; surface multicostellate, 5-7 costae and costellae per mm; spinule bases abundant; and up to six pairs of spines diverging from hinge line at an angle of 33° . Brachial valve evenly concave or with a low, inconspicuous fold; ornamentation as on pedicle valve; and interarea reflexed.

Brachial interior with small, low cardinal process, bilobed internally, tetralobed externally; small chilidium present; alveolus small, shallow; median septum low, extending to near mid-length, slightly higher anteriorly, although some specimens have only a single row of slightly coalesced endospines as septum; two short, thin, and low lateral septa diverging from area anterior to alveolus at an angle of 51° ; inner socket ridges strong, not extending along hinge line; outer socket ridges absent to slightly developed; and radiating rows of endospines covering surface except for posterior area bordering hinge line.

Pedicle interior with a small, narrow pseudodeltidium; teeth small, slightly elongated; median septum fairly high beneath beak and extending as a low, rounded ridge to near mid-length; adductor scars and diductor scars not impressed; endospines, arranged in radial rows, covering inner surface except in the muscle scar areas; and no vascular trunk present.

Discussion.—*Chonetinella plebeia* has been raised to specific rank on the basis of comparative studies of growth forms of it, *C. alata*, and *C. flemingi*. At first glance *C. plebeia* appears to be a juvenile form of *C. flemingi*. Specimens of comparable size show distinct differences in development. The features on the interior surfaces of the valves are consistently less developed in *C. plebeia* than in either of the other two species and the overall shape is less alate at all stages of growth. The development of the sulcus in *C. plebeia* is similar to that of *C. alata* but distinct from that of *C. flemingi*. The costae and costellae are lower and less developed in *C. plebeia* than in *C. alata* or *C. flemingi*. *C. ? rostrata* (Dunbar & Condra) has a more pronounced sulcus, a higher beak area, and a more subquadrate shape than *C. plebeia*, *C. ? primitiva* (King)

has a much more pronounced sulcus and *C. robusta* King has a more pronounced sulcus and more distinct costae and costellae, and *C. papilioniformis* (Newell) has a more pronounced sulcus and bordering ridges and larger costae and costellae.

Occurrence.—Abundant in the Brush Creek and Cambridge units.

Repository.—Hypotypes, OSU-25890 to 25899.

Chonetinella verneuliana var.

Pl. 5, figs. 5-7

Shell small, alate, strongly convex, with greatest width at hinge line. Pedicle valve with lateral margins gently to strongly convex, converging anteriorly; anterior margin narrow, deeply sinuate; deep, narrow median sulcus strongly developed, bordered by slightly diverging ridges with steep slopes making lateral areas of the pedicle valve strongly concave; surface multicostellate, 6-7 costae and costellae per mm; spinule bases common; and up to seven pairs of spines diverging from hinge line at an angle of 22°. Brachial valve strongly concave with pronounced fold; ornamentation as on pedicle valve; and interarea reflexed.

Brachial interior with a low median septum, becoming higher anteriorly, extending past mid-length; a pair of low lateral septa; inner socket ridges low, short; and only lateral and anterior portions of the surface bear radially arranged endospines. Other internal features not observed.

Pedicle interior with small pseudodeltidium, small elongate teeth. Other internal features not observed.

Discussion.—A few specimens from several localities form the basis for the above description. Most characteristics present indicate that the specimens belong to *Chonetinella verneuliana* (Norwood & Pratten), but they differ from that species by being smaller and more alate in form and in having a larger number of spines along the hinge line coinciding with the smaller sized specimens. Both *C. verneuliana* var. *wyandottensis* (Newell) and *C. papilioniformis* (Newell) are less alate forms than *C. verneuliana*.

Occurrence.—Rare to common in the Portersville unit and rare in the Cambridge unit.

Repository.—Hypotypes, OSU-25888, 25889.

Chonetinella crassiradiata (Dunbar & Condra)

Pl. 3, figs. 20-23

Chonetina flemingi var. *crassiradiata* Dunbar & Condra, 1932, p. 157, 158, pl. 19, figs. 37-40.

Chonetinella flemingi var. *crassiradiata* Hoare, 1961, p. 35-37, pl. 2, figs. 1-4; Muir-Wood, 1962, p. 86.

Shell small, with greatest width at hinge line. Pedicle valve with cardinal extremities produced; lateral margins rounding smoothly into nearly straight anterior margin; beak small, slightly overhanging interarea;

median sulcus shallow beginning at umbo, becoming wider anteriorly; areas bordering sulcus sloping steeply towards ears, forming concave surface in postero-lateral portions of valve; surface multicostellate, 4-5 costae and costellae per mm; spinule bases present; and up to six pairs of spines diverging from hinge line at a low angle. Brachial valve concave, more strongly so in centroposterior region; fold low, ornamentation as on pedicle valve; and interarea reflexed.

Pedicle interior with small pseudodeltidium and a short, low median septum. Other internal features not observed. Two nearly complete and uncrushed specimens average 5.7 mm in length, 8.9 mm in width, and 2.3 mm in thickness.

Discussion.—*Chonetinella crassiradiata* differs from the other species of this genus described herein by the greater coarseness and fewer number of costae and costellae per unit area. *C. plebeia* is most likely to be confused with *C. crassiradiata* but the former, in addition to the finer costae and costellae, has a more pronounced sulcus, less distinct lateral humps, and less highly arched beak and umbonal area. *C. robusta* King has a deeper sulcus and stronger umbo and *C. papilioniformis* (Newell) has a deeper sulcus and finer costae and costellae than *C. crassiradiata*.

Occurrence.—Rare in the Putnam Hill, Vanport, and Columbiana units and questionably present in the Tuscarawas unit.

Repository.—Hypotypes, OSU-27033; MU-10918.

Genus *Neochonetes* Muir-Wood, 1962

Neochonetes semiacanthus (Lintz)

Pl. 8, figs. 1-6

Chonetes granulifer Mark, 1912, p. 300, 301, pl. 13, fig. 3.

Chonetes granulifer var. *semiacanthus* Lintz, 1958, p. 99-102, pl. 16, figs. 2-9.

Neochonetes granulifer var. *semiacanthus* Muir-Wood, 1962, p. 88.

Shell small, subquadrate in outline, with greatest width at the hinge line. Pedicle valve moderately convex, with faint sulcus in some specimens; ears slightly produced; surface multicostellate, with subangular, closely spaced costae and costellae, 4-5 per mm; numerous fine spinule bases; fine, closely spaced, lamellae growth lines present; up to seven spines on each side of beak, extending at an angle of 30° to interarea; beak low, umbo not inflated; and greatest thickness posterior to mid-length. Brachial valve with similar ornamentation; moderately concave; and interarea slightly reflexed.

Brachial interior covered with endospines, smaller and more radially arranged near anterior and lateral margins; cardinal process prominent, internally bilobate, externally tetralobate, with distinct chilidial plates; strong inner socket ridges and slightly developed outer socket ridges; sockets prominent; alveolus

small; median septum prominent, extending over half valve length; a pair of lateral septa, diverging at an angle of 48° from each other, fused together anterior to the alveolus; adductor scars weak to prominent; and brachial ridges weak to well developed.

Pedicle interior with endospines similar to those of brachial valve; small pseudodeltidium partially filling pedicle opening; teeth strong, slightly elongated; median septum a thin, high plate posteriorly, becoming a low, rounded ridge which may extend three-fourths of valve length; vascular trunks of rows of larger endospines present in some cases; gerontic specimens with vascular trunks of heavy ridges; larger diductor scars weak to strongly impressed; and adductor scars small, weakly impressed, except in gerontic specimens, where they are present on elevated platforms.

Discussion.—*Chonetes granulifer* var. *semiacanthus* was described by Lintz (1958) from specimens obtained from the Ames and Brush Creek shales in cores taken in the Georges Creek and Castleman basins, Maryland. A large number of well-preserved specimens from the Ames limestone and shale of Ohio, when compared with specimens described by Lintz and kept in the repository of The Johns Hopkins University, show a marked correspondence in all characters except for the slightly smaller size of the Maryland specimens. Lintz notes the lack of spinule bases on the Maryland specimens but several show this feature when wet. Although *Neochonetes granulifer* (Owen) also occurs in the Ames limestone, it has not been found associated with specimens of *N. semiacanthus*.

N. semiacanthus differs from *N. granulifer* in being consistently smaller, in having costae and costellae of a more angular shape, in having a less pronounced beak and umbo, and in having, in most specimens, less pronounced vascular trunks and brachial ridges. *N. granulifer* var. *armatus* (Girty) has more numerous costae and costellae and is less transverse than *N. semiacanthus*. *N. granulifer* var. *emaciatius* (King) has a more prominent beak and umbonal region and is less quadrate in outline than *N. semiacanthus* and *N. dominus* (King) has more prominent brachial ridges and vascular trunks and a stronger convexity of the pedicle valve.

Occurrence.—Abundant to rare in the Ames unit and rare in the Gaysport and Skelley units.

Repository.—Hypotypes, OSU-25867 to 25871.

Neochonetes granulifer (Owen)

Pl. 9, figs. 1-19

Chonetes granulifer Owen, 1852, p. 583, pl. 5, figs. 12a-d; [non] Mark, 1912, p. 300, 301, pl. 13, fig. 3; Girty, 1915, p. 59-62, pl. 7, figs. 12-13b (see for synonymy); King, 1930, p. 60, 61, pl. 9, fig. 14; Dunbar & Condra, 1932, p. 138-143, pl. 18, figs. 1-10.

Neochonetes granulifer Muir-Wood, 1962, p. 87, 89, pl. 10, figs. 8, 15; pl. 11, fig. 5, text-fig. 23; --- (in Moore, 1965), p. 431, 432, fig. 289, 1c.

Shell small to medium, with greatest width at the hinge line. Pedicle valve with lateral margins concave anterior to hinge line and converging anteriorly into straight to slightly convex anterior margin; median sulcus absent; lateral slopes gently concave; surface multicostellate, with broadly rounded costae and costellae, 4-5 per mm at anterior margin; numerous spinule bases; growth lines conspicuous near anterior margin; up to seven pairs of spines bordering hinge line, diverging at an angle of 24° . Brachial valve with similar ornamentation; concave; and with reflexed interarea.

Brachial interior with a heavy cardinal process, bilobate internally, tetralobate externally; chilidial plates present; distinct alveolus bordered by a heavy callus where inner socket ridges, lateral septa, and median septum meet; heavy inner socket ridges; outer socket ridges absent to weakly developed, sockets large; a pair of lateral septa diverging at an angle of 78° , with anterior portions merging with strongly developed brachial ridges; median septum extending to near mid-length of valve, highest anteriorly, irregular in shape; muscle scars strongly impressed; and anterior and lateral portions of surface covered with radiating rows of endospines, papillose in arrangement near valve margins.

Pedicle interior with pseudodeltidium partially filling delthyrium; teeth commonly short, heavy, elongated in some specimens; median septum thin, high, beginning under beak and extending as a low, rounded ridge to near mid-length; diductor scars slightly to strongly impressed, with an outer ridge; adductor scars slightly impressed or on raised platforms; vascular trunks developed from rows of fused endospines; and endospines covering surface except for scar areas, papillose at valve margins, and enlarged in areas bordering scars in gerontic individuals.

Discussion.—The specimens described above match well the illustrations and descriptions of *Chonetes granulifer* by Owen (1852), Girty (1915a), and Dunbar and Condra (1932). Slight differences in size are observable but are not deemed significant. *N. granulifer* is easily distinguished from *N. semiacanthus* (Lintz), as discussed under the latter species. A small collection of specimens from the Portersville shale are also included under this designation. These specimens have thinner, less convex shells with more prominent spinule bases, as in *N. acanthophorus* (Girty) (= *C. granulifer* var. *armatus* Girty, 1911). It is doubtful that this form is significantly different from *N. granulifer*.

Occurrence.—Abundant in the Ames unit and at one locality in the Portersville unit.

Repository.—Hypotypes, OSU-25851 to 25866.

Genus *Leptalosia* Dunbar & Condra, 1932*Leptalosia ovalis* Dunbar & Condra

Pl. 10, figs. 19, 20

?Strophalosia spondyliiformis Girty, 1915, p. 80, pl. 10, fig. 8.*Leptalosia ovalis* Dunbar & Condra, 1932, p. 263, 264, pl. 32, fig. 12.

Shell very small, with hinge line equal to or less than greatest width, giving a transversely subquadrate or suboval shape. Pedicle valve attached by entire surface to substrate, commonly some other shell; shell material thin; variable number of adnate spines radiating from margin of valve; and interarea very short. Internal features and brachial valve not observed. Four specimens average 1.5 mm in length and 1.6 mm in width.

Discussion.—*Leptalosia ovalis* is distinguished from *L. spondyliiformis* (White & St. John) by its shape. The latter species is subtriangular in shape, with the greatest width very near the anterior margin. A triangularly shaped cardinal area is also characteristic of the latter species. The shell of *L. ovalis* varies somewhat in shape because of the configuration of the substrate shell or because of crowding of individuals.

Occurrence.—Rare in the Washingtonville and Ames units.

Repository.—Hypotypes, OSU-27024 to 27025.

Genus *Fimbriaria* Muir-Wood & Cooper, 1960*?Fimbriaria* sp.

Pl. 11, fig. 7

Shell small, subcircular, with greatest width between hinge and mid-length. Pedicle valve with small beak overhanging hinge; convex ventral region; spreading flanks; ears flat; and surface noncostellate, marked by concentric rugae, each bearing a row of small spines from ears across venter. Width at hinge line, 4.0 mm, maximum width, 6.0 mm, arc length, 4.0 mm, height, 1.5 mm. Brachial valve concave and marked by concentric rugae. Other features not observed.

Discussion.—One pedicle valve and a partial external mold of a brachial valve form the basis for this description. Although immature, the specimens appear to have the characteristics of the genus *Fimbriaria*. The only North American Pennsylvanian species of this genus so far recognized is *F. plummeri* (R. H. King). Comparison with other species is difficult because of the immaturity of the specimens.

Occurrence.—Rare in the Ames unit.

Repository.—Hypotype, OSU-27022.

Genus *Krotovia* Frederiks, 1928*Krotovia paucispina* n. sp.

Pl. 12, figs. 24-26

Shell small, subcircular, with greatest width at

about mid-length. Pedicle valve convex; beak small; venter uniformly convex; flanks flaring; ears large and flattened; numerous small, erect spines arranged in quincunx pattern on umbo, crowded on low rugae on ears, and arranged in rough concentric rows laterally and anteriorly; and growth lines numerous, more conspicuous anteriorly. Brachial valve and interior features unknown.

Discussion.—The above description is based upon three partial specimens. Characteristics of size, shape, and ornamentation are well shown, allowing comparison with known species of *Krotovia*. The only species previously described from the Pennsylvanian of North America is *K. knighti* (Newell) (1934), from the Missourian Series of Kansas. This species differs from *K. paucispina* in having far fewer spines, which are arranged quincunxially over the entire pedicle valve, and in having the maximum width located closer to the hinge line. Newell also notes the presence of obscure costae on the holotype of *K. knighti*, a feature which does not appear on any of the specimens described above. *K. nielsoni* Dunbar (1955), from the Upper Permian of Greenland, is much more abundantly spinose than *K. paucispina*.

Occurrence.—Rare in the Lower Mercer unit.

Type locality.—The Lower Mercer limestone and shale at locality Vel-6. The species is associated with *Antiquatonia costellata*, *Juresania nebrascensis*, *Juresania* sp., *Desmoinesia muricata* var. *missouriensis*, *Echinaria* sp., *Linoproductus planiventralis*, *Linoproductus* sp., *Hustedia mormoni*, *Cleiothyridina orbicularis*, *Derbyia crassa*, *Rhipidomella carbonaria*, *Schizophoria resupinoides*?, *Punctospirifer kentuckyensis*, *Anthracospirifer occiduus*, *A. rockymontanus*?, *Composita subtilita*?, *C. ovata*?, *Plicochonetes dotus*, *Rugosochonetes delicatus*, and *Orbiculoidea missouriensis*.

Repository.—Holotype, OSU-27021; paratypes, OSU-27019, 27020.

Krotovia sp.

Pl. 12, figs. 27, 28

Shell small, subquadrate, with greatest width at hinge line. Pedicle valve with small beak, tightly incurved over hinge line; venter uniformly rounded; lateral slopes steep; ears large, slightly arched; posterior portion of valve moderately rugose; anterior portion faintly costellate, 6 ribs per 3 mm; and numerous small spines borne on the rugae and ribs in a rough quincunx pattern. Measurements possible are: width at ears, 11.0 mm, and arc length, 14.0 mm. Brachial valve and internal characteristics unknown.

Discussion.—One nearly complete specimen forms the basis for the above description. Although the specimen differs from specimens of known species of *Krotovia*, additional material is necessary to adequately distinguish it specifically. *K. paucispina* n. sp. lacks any trace of ribs and has larger spines arranged in con-

centric rows, and *K. knighti* (Newell) (1934) has larger spines arranged in a quincunx pattern and more faintly developed ribs than does this form.

Occurrence.—Rare in the Putnam Hill unit.

Repository.—Hypotype, OSU-9792.

Genus *Hystriculina* Muir-Wood & Cooper, 1960

Hystriculina wabashensis (Norwood & Pratten)

Pl. 12, figs. 11-14

Productus wabashensis Norwood & Pratten, 1855, p. 13, pl. 1, figs. 6a-d.

Marginifera wabashensis Dunbar & Condra, 1932, p. 234-236, pl. 35, fig. 23, pl. 36, figs. 18-23, 25, 26; [non] Morningstar, 1922, p. 184, 185, pl. 9, figs. 6-10.

Shell small, subrectangular, with greatest width at the hinge. Pedicle valve with rounded umbo; flanks steep with ears set off by narrow furrow; beak and ears small; surface costellate; visceral disc weakly rugose; median sulcus narrow, shallow; 4-6 small spines on visceral disc, 1-3 spines along hinge on each side of beak; and 10-12 larger spines scattered over valve. Brachial valve strongly concave; faint costellae and rugae; and no spines.

Brachial interior with short, small cardinal process, bilobate internally, trilobate externally; crenulate lateral ridges diverging from hinge, curving across ears and part way down lateral margins; brachial ridges weak, open proximally; median septum low, extending over half valve length; adductor scars not prominent; 32 spines in two rows anterior to brachial ridge; and anterior margin, posterior to geniculation, marked with radial rows of endospines. Measurements of five specimens are given in table 5.

Discussion.—*Hystriculina wabashensis* differs from *H. hystricula* (Dunbar & Condra) by being less spinose and more weakly costellate. *H. fragilis* (Dunbar & Condra) is more spinose than *H. wabashensis* and the sulcus is less distinct. *H. texana* Muir-Wood & Cooper has stronger costae and costellae and a narrower and deeper sulcus than does *H. wabashensis*.

TABLE 5.—Measurements of *H. wabashensis* (Norwood & Pratten) from the Ames

	Specimen				
	1	2	3	4	5
Arc length (mm)	21	18	22	21	22
Width at ears (mm)	16	16	18	16	17
Height (mm)	7	8	7	8	8
Arc length at which last rugae noted (mm)	9	9	9	8	9
Arc length at which sulcus originates (mm)	5.5	7	8	10	11
No. of spines on one side of hinge line	2	3	2	2	2
No. of ribs in 3 mm at arc length 10 mm	6	5	5	6	5

Occurrence.—Rare to common in the Ames unit and rare in the Skelley unit.

Repository.—Hypotypes, OSU-25982 to 25984.

Genus *Kozlowskia* Frederiks, 1933

Kozlowskia haydenensis (Girty)

Pl. 12, figs. 1-5

Marginifera haydenensis Girty, 1903, p. 380, pl. 5, figs. 9-11a; Dunbar & Condra, 1932, p. 232-234, pl. 36, figs. 12-17; [non] Pederson, 1954, p. 21, pl. 2, figs. 17-19.

Marginifera wabashensis Morningstar, 1922, p. 184, 185, pl. 9, figs. 6-9, [non] fig. 10.

Kozlowskia haydenensis Muir-Wood & Cooper, 1960, p. 213, pl. 63, fig. 12; Hoare, 1961, p. 59, 60, pl. 4, figs. 9-16; Muir-Wood (in Moore, 1965), p. 479, fig. 345, 4b.

Shell small, subquadrangular, with greatest width at the hinge. Pedicle valve with flattened visceral disc; small beak and ears; weakly developed costae, costellae, and rugae; lateral flanks steep with ears set off by narrow furrow; narrow, shallow median sulcus present in some specimens; 6-7 halteroid spines, 2-3 on front of venter, 1 on each flank and 1 at each cardinal extremity; and 1 or 2 smaller spines along hinge and up to 13 small spines scattered over visceral disc. Brachial valve gently concave with faint costae, costellae, and rugae; no spines; and lateral and anterior margins lamellate, formed by broken edges of successive trails.

Brachial interior with small, erect, trilobate cardinal process; lateral ridges extending along hinge, curving across ears, crenulated down lateral margins, then curving across anterior margin of visceral disc; median septum over half valve length, highest anteriorly; brachial ridges distinct, open proximally; elongate, oval, nondendritic anterior adductor scars and smaller, laterally placed, subtriangular posterior adductor scars; and one row of 4-8 spines anterior to brachial ridges. Measurements of five specimens are given in table 6.

TABLE 6.—Measurements of *K. haydenensis* (Girty) from the Lower Mercer

	Specimen				
	1	2	3	4	5
Arc length (mm)	22.5	20	23	21	21
Width at ears (mm)	12	13	14	12.5	14
Height (mm)	7	7	8	7	7
Arc length at which last rugae noted (mm)	7	8	7.5	10	9.5
Arc length at which sulcus originates (mm)	4	-	7	5.5	6.5
No. of spines on one side of hinge line	1	2	2	2	2
No. of ribs in 3 mm at arc length 10 mm	6	7	7	6	8

Discussion.—*Kozlowskia haydenensis* differs from *K. splendens* (Norwood & Pratten) by being smaller in size and more quadrangular in shape and in having a less distinct median sulcus and smaller and less arched ears with fewer spines on them. *K. kingi* Stehli, from the Bone Spring Limestone of Permian age in Texas, is larger, more transverse, has larger ears, and is more faintly costellate than *K. haydenensis*.

Occurrence.—Rare to abundant in the Lower Mercer, Upper Mercer, and Putnam Hill units. Reported by Morningstar (1922) as rare to abundant in the Boggs and Lowellville units.

Repository.—Hypotypes, OSU-25974 to 25977.

Kozlowskia splendens (Norwood & Pratten)
Pl. 12, figs. 6-10

Productus splendens Norwood & Pratten, 1855, p. 11, pl. 1, figs. 5a-d.

Productus longispinus Mark, 1912, p. 302, pl. 13, fig. 8.

Marginifera splendens Girty, 1915, p. 76, pl. 10, figs. 1-26; Dunbar & Condra, 1932, p. 228-232, pl. 35, figs. 17-22, 24-26.

Marginifera wabashensis Morningstar, 1922, p. 184, 185, pl. 9, fig. 10.

Kozlowskia splendens Muir-Wood & Cooper, 1960, p. 213, pl. 62, figs. 14-23; pl. 63, figs. 1-11; Muir-Wood (*in* Moore, 1965), p. 479, figs. 345, 4c-f.

Shell small to medium-sized, subrectangular, with greatest width at the hinge. Pedicle valve with small beak; flattened visceral disc; flanks steep; ears pronounced, set off by shallow furrow; weak costellae; visceral disc weakly rugate; 6-7 halteroid spines, 1 in sulcus, a pair bordering sulcus, 1 on each flank, and 1 on each of the cardinal extremities; 4-5 small spines scattered on visceral disc; median sulcus narrow, moderately deep. Brachial valve concave; faintly costellate; weakly developed rugae; lateral and anterior margins lamellate, formed by broken edges of successive trails; and no spines.

Brachial interior with short, erect, trilobate cardinal process; lateral ridges paralleling hinge, curving across ears and down lateral margins before curving smoothly into anterior margin; ridge crenulate in region of ears; median septum bladeliike, highest anteriorly, extending just over half valve length; brachial ridges distinct, open proximally; anterior adductor scars elongate-oval; posterior adductor scars located laterally, subtrigonal in shape; and 21 spines, in two rows, present anterior to brachial ridges. Measurements of five specimens are given in table 7.

Discussion.—*Kozlowskia splendens* differs from *K. kingi* Stehli by its more pronounced median sulcus and smaller ears. *Hystericulina wabashensis* (Norwood & Pratten) can easily be confused with *K. splendens*. The costellae on the pedicle valve of the former are

more distinct and the brachial valve lacks the interior ridge around the anterior margin and the margin is not lamellose as in species of *Kozlowskia*. The pedicle valve of *H. wabashensis* is generally less spinose than that of *K. splendens* although the specimens of *H. wabashensis* from the Ames limestone are more spinose than specimens of *K. splendens* in the Cambridge and Brush Creek.

Occurrence.—Rare in the Vanport and Ames units and rare to abundant in the Brush Creek and Cambridge units.

Repository.—Hypotypes, OSU-25978 to 25981.

TABLE 7.—Measurements of *K. splendens* (Norwood & Pratten) from the Lower Brush Creek

	Specimen				
	1	2	3	4	5
Arc length (mm)	25	29	23	23	24
Width at ears (mm)	17.5	26	18	19	18
Height (mm)	9	10	9	10	9
Arc length at which last rugae noted (mm)	11	11.5	12	13	13
Arc length at which sulcus originates (mm)	7	7	8	9	7
No. of spines on one side of hinge line	3	2	2	2	2
No. of ribs in 3 mm at arc length 10 mm	5	4	5	6	8

Genus *Desmoinesia* Hoare, 1960
Desmoinesia muricata (Dunbar & Condra)
Pl. 12, figs. 20-23

Productus muricatus Norwood & Pratten, 1855, p. 14, pl. 1, figs. 8a-e.

Desmoinesia muricata Hoare, 1961, p. 61-63, pl. 4, figs. 17-22 (see for synonymy); Muir-Wood (*in* Moore, 1965), p. 479, figs. 347, 2a-f.

Shell small, subrectangular, with greatest width at or just anterior to the hinge. Pedicle valve with small beak; flattened ears; umbo rounded; flanks moderately steep; venter flattened or with faint, shallow sulcus; surface costellate, rugose posteriorly and medianly; and spines scattered over valve on costellae, along hinge, and in row up flanks. Brachial valve slightly concave; costellate; rugate; and with several spines on anterior and lateral portions of valve.

Brachial interior with short, small, trilobate cardinal process, median lobe grooved, lateral lobes converging externally with median lobe; low lateral ridges diverging from hinge and disappearing at or before ears; median septum broad posteriorly, low and thin anteriorly, extending over half valve length; adductor scars not prominent; brachial ridges faint; and numerous endospines, larger just anterior to brachial ridges, smaller between brachial ridges and median septum

and on recurved anterior portion of valve. Measurements of five specimens are given in table 8.

Discussion.—*Desmoinesia muricata* is easily distinguished from species of *Kozlowskia* and *Hystriculina* by lack of a sulcus, by its more spinose character, and by features of the anterior margin. The lateral ridges are more weakly developed and the anterior portion of the brachial valve interior is more spinose than in *Kozlowskia* and *Hystriculina*. *D. muricata* also has spines on the external surface of the brachial valve.

Occurrence.—Abundant in the Lowellville and Boggs units; common to abundant in the Lower Mercer unit; and rare to abundant in the Putnam Hill, Vanport, Columbiana, and Washingtonville units. Also reported from the Upper Mercer unit by Morningstar (1922).

Repository.—Hypotypes, OSU-25985 to 25987.

TABLE 8.—Measurements of *D. muricata*
(Dunbar & Condra) from the Vanport

	Specimen				
	1	2	3	4	5
Arc length (mm)	22	20	21	21	20
Width at ears (mm)	16	14	15	13	15
Maximum width (mm)	16	15.5	15.5	17	15.5
Height (mm)	7	6.5	6	7	6
Arc length at which last rugae noted (mm)	22	15	12	13	17
No. of spines on one side of hinge line	4	6	6	5	5
No. of ribs in 3 mm at arc length 10 mm	5	6	4	4	5

Desmoinesia muricata var. *missouriensis* (Girty)
Pl. 12, figs. 15-19

Marginifera muricata var. *missouriensis* Girty, 1915, p. 350, pl. 30, figs. 2-5a; Morningstar, 1922, p. 184, pl. 9, fig. 4, [non] figs. 1-3, 5; Kelly, 1930, p. 145, pl. 11, figs. 6, 7; Dunbar & Condra, 1932, p. 224, pl. 35, figs. 11-16.

Shell small, subquadrangular, with greatest width anterior to the hinge. Pedicle valve with small beak and ears; umbo rounded; flanks moderately steep; ears set off by narrow furrow; venter rounded to flattened; strongly costellate; rugate in posterior portion; and numerous small spines borne by costae and costellae and along hinge. Brachial valve strongly concave.

Pedicle interior with a pair of small, suboval, medianly located adductor scars; large, elongately lobed diductor scars positioned laterally to the adductors and extending farther anteriorly; and anterior and lateral portions of valve with numerous small endospines.

Brachial interior with short cardinal process, bilobate internally with deep median groove, trilobate

externally where lateral lobes meet with median lobe; lateral ridges diverging from hinge, curving across ears and part way down lateral margin; median septum narrow, blade-like, highest anteriorly, extending less than half valve length; brachial ridges prominent, open proximally; anterior adductor scars elongate-oval, posterior adductor scars not conspicuous; and numerous endospines anterior to brachial ridges and between brachial ridges and median septum. Measurements of five specimens are given in table 9.

TABLE 9.—Measurements of *D. muricata* var. *missouriensis*
(Girty) from the Lower Mercer

	Specimen				
	1	2	3	4	5
Arc length (mm)	22	23	22	20	24
Width at ears (mm)	13	10	11	12	12
Maximum width (mm)	15	13	13	15	14
Height (mm)	8	8	7	7	7.5
Arc length at which last rugae noted (mm)	11	9	11	11	10
No. of spines on one side of hinge line	7	6	6	5	6
No. of ribs in 3 mm at arc length 10 mm	6	6	7	7	6

Discussion.—Girty (1915b) proposed the new variety *Marginifera muricata* var. *missouriensis* for specimens in the midcontinent region. He noted, among other characters, the less transverse shape, smaller size, more regular costae, and more distinct rugae which differentiated it from typical specimens of *M. muricata*. Prior to this time Meek and Worthen (1866) proposed a new species: *?Productus nanus* from the Pennsylvanian in Iowa. In general this form was the same as that to which Girty applied the varietal name *missouriensis* except that in *?P. nanus* the anterior margin of the pedicle valve was marked by the even division of the costellae, forming a much finer costellate band. Girty, noting this, felt his variety distinct as his specimens did not show the finely costate margin.

Dunbar and Condra (1932) felt the two were synonymous and used Girty's designation since Meek and Worthen's description was inadequate and type locality was unknown. The variety was raised to specific rank as *Marginifera missouriensis* (Girty). Hoare (1960, 1961) also felt these two forms were synonymous but retained Meek and Worthen's designation and grouped these forms in synonymy under the designation *Desmoinesia nana* (Meek & Worthen). Specimens from the Seville Limestone and caprock of the Rowe Coal in southwestern Missouri have a finely costellate margin.

Numerous specimens from the Lower Mercer limestone and shale in Ohio have characteristics much like those of the specimens described by Girty and do not have a finely costellate band anteriorly. It is now felt that the forms *nana* and *missouriensis* are distinct,

based upon several known and widely separated occurrences of the two, and that they should be recognized as varieties of *D. muricata* and not as distinct species.

D. muricata var. *missouriensis* differs from *D. muricata* by being less transverse in shape and smaller and by having more prominent costellae and rugae and more strongly developed internal features on the brachial valve. It differs from the variety *nana* by lacking the finely costellate anterior margin, formed by the uniform bifurcation of the costellae, of the pedicle valve.

Occurrence.—Common to abundant in the Lower Mercer unit.

Repository.—Hypotypes, OSU-25988 to 25991.

Genus *Echinaria* Muir-Wood & Cooper, 1960

Echinaria semipunctata (Shepard)

Pl. 13, figs. 1-7

Productus semipunctatus Shepard, 1838, p. 153, fig. 9.

Productus punctatus Mark, 1912, p. 303, pl. 13, fig. 6.

Pustula semipunctata Girty, 1915, p. 349.

Pustula punctatus Morningstar, 1922, p. 183, 184, pl. 8, fig. 9.

Echinochonus semipunctatus Dunbar & Condra, 1932, p. 205-207, pl. 24, fig. 6; pl. 25, figs. 1-3b.

Echinaria semipunctata Muir-Wood & Cooper, 1960, p. 248, pl. 85, figs. 1-5; pl. 86, figs. 1-4, 6-9; Muir-Wood (in Moore, 1965), p. 485, figs. 354, 1a-e.

Shell large, subtrigonal, with greatest width anterior to the hinge. Pedicle valve with umbo strongly incurved over hinge; visceral disc very convex; venter medianly flattened or sulcate with steep flanks; ears small; trail curved; ornament of numerous concentric lamellose bands bearing three rows of spines, those of posterior row being larger and of anterior smaller on each band; and bands narrower anteriorly and on flanks. Brachial valve gently concave; low, broad median fold; not geniculate; and ornament of narrow concentric bands bearing up to three rows of spines with arrangement as on pedicle valve, although spines in general are smaller.

Pedicle interior with long, thin median septum separating a pair of elongate, narrow, elevated, dendritic, posteriorly tapering adductor scars which extend farther posteriorly than diductors; anterior portion reflecting external concentric bands and lamellae; and no endospines.

Brachial interior with heavy, dorsally curving cardinal process with a narrow median sulcus internally and an additional median lobe externally, making it trilobate; lateral ridges paralleling hinge, reaching to, or nearly to, ears; heavy median septum supporting process, larger posteriorly, with a median sulcus in area of adductor scars, and extending about half valve

length; posterior adductor scars large, elongate, dendritic; anterior adductor scars small, smooth, suboval, or set on heavy platform built on median septum; brachial ridges obscure to strong, closed proximally; and small endospines on surface anterior to median septum. Measurements of two specimens are given in table 10.

Discussion.—*Echinaria semipunctata* is the largest brachiopod in the Pennsylvanian System in Ohio. It is easily distinguished from species of *Juresania* and *Pulchratia* on the basis of its median sulcus, overall shape, and arrangement of spines. *E. semipunctata* var. *knighti* (Dunbar & Condra) differs from *E. semipunctata* in being smaller and more ovate in shape, and in having a less pronounced sulcus. *E. moorei* (Dunbar & Condra) is smaller, with a stronger concavity to the brachial valve and narrower lamellose bands, and is more spinose, with up to four rows of spines on each band.

Occurrence.—Rare to abundant in the Cambridge unit.

Repository.—Hypotypes, OSU-25999 to 26004.

TABLE 10.—Measurements of *E. semipunctata* (Shepard) (1, 2) from the Cambridge, *E. semipunctata* var. *knighti* (Dunbar & Condra) (3) from the Lower Mercer, and *E. moorei* (Dunbar & Condra) (4) from the Ames

	Specimen			
	1	2	3	4
Arc length (mm)	134	130	69	87
Width at ears (mm)	46	42	21	29
Maximum width (mm)	81	75	40	45
Height (mm)	41	42	19	23
Arc length at which sulcus originates (mm)	14	16	21	12
Width of sulcus at arc length 50 mm (mm)	15	10	9	14

Echinaria semipunctata var. *knighti*

(Dunbar & Condra)

Pl. 14, figs. 6-9

Productus symmetricus White, 1884 [non McChesney, 1860], p. 123, pl. 25, figs. 1, 2.

Echinochonus semipunctatus var. *knighti* Dunbar & Condra, 1932, p. 208, 209, pl. 26, figs. 1-3.

Shell medium-sized, suboval in shape, with major characteristics of this species. Measurements of a specimen from the Lower Mercer are given in table 10.

Discussion.—*Echinaria semipunctata* var. *knighti* differs from *E. semipunctata* in being consistently smaller and more oval in shape. The concentric bands on the variety are distinctly narrower at the same arc lengths than they are on *E. semipunctata*. As shown by well-preserved brachial valves, the width of the hinge in var. *knighti* is only slightly less than the

maximum width of the form and the muscle scars and brachial ridges are not as strongly developed as in *E. semipunctata*. The muscle scars in the pedicle valve of the variety are more lightly impressed and the adductors less dendritic in structure than in *E. semipunctata*.

Occurrence.—Rare in the Boggs, Lower Mercer, Vanport, and Washingtonville units and rare to abundant in the Columbiana unit. Also reported from the Upper Mercer unit by Morningstar (1922).

Repository.—Hypotypes, OSU-26005 to 26007.

Echinaria moorei (Dunbar & Condra)
Pl. 14, figs. 1-5

Echinoconchus moorei Dunbar & Condra, 1932, p. 209-211, pl. 24, figs. 1-5.

Echinaria moorei Muir-Wood & Cooper, 1960, p. 248, pl. 86, fig. 5.

Shell medium-sized, elongate-oval, with greatest width anterior to the hinge. Pedicle valve with strongly recurved umbo; strongly convex posterior portion with steep flanks; ears small; medianly sulcate; and numerous narrow, lamellose concentric bands bearing up to four rows of mainly prostrate spines. Brachial valve concave posteriorly; subquadrangular in shape; not geniculate; low, broad median fold; and numerous lamellose concentric bands, narrower than those of pedicle valve and bearing abundant spines in several rows.

Brachial interior with narrow, high cardinal process curved dorsally, bilobate anteriorly with median sulcus, trilobate externally, process supported by narrow, low median septum extending over half valve length; lateral ridges short, heavy, diverging slightly from hinge; adductor scars elongate, suboval, dendritic posteriorly, smooth and more strongly raised anteriorly; brachial ridges obscure; and numerous small endospines in concentric rows, smaller and fewer near margin. Pedicle interior not observed. Measurements are given in table 10.

Discussion.—Differences between *Echinaria moorei* and *E. semipunctata* (Shepard) are discussed under the latter species. *E. semipunctata* var. *knighti* (Dunbar & Condra) is more oval in shape, and has a shallower sulcus, less concavity to the brachial valve, and fewer rows of spines on the concentric bands than has *E. moorei*.

Occurrence.—Rare in the Ames unit.

Repository.—Hypotypes, OSU-26008 to 26010.

Genus *Pulchratia* Muir-Wood & Cooper, 1960
Pulchratia symmetrica var. *regularis* n. var.
Pl. 15, figs. 12-17

Shell medium to large, suboval, with greatest width

near the anterior margin. Pedicle valve with small beak; umbo rounded, slightly overhanging hinge; flanks gently sloping, spreading anteriorly; ears large; venter flattened to slightly sulcate; rugose posteriorly and on ears; lamellose anteriorly; spines of three types, larger type erect and two smaller types prostrate, occurring in large group on rugae on ears, on rugae posteriorly, and on lamellose bands anteriorly; and spines more erect posteriorly and more prostrate anteriorly. Brachial valve gently concave or flattened; somewhat geniculate with curved trail; posteriorly rugose and anteriorly lamellose; and numerous spines on rugae and lamellose bands.

Brachial interior with strong cardinal process, bilobed anteriorly, trilobed posteriorly, with median sulcus; three lobes of myophore converging but not uniting on external face; lateral ridges paralleling hinge nearly to ears, diverging slightly near ends; median septum supporting process and extending just past mid-length of valve; adductors large and elongate with posterior portion dendritic and anterior portion smooth; brachial ridges obscure; and surface rugose in appearance with numerous endospines arranged in concentric rows on anterior portion. Measurements of five specimens are given in table 11.

Discussion.—*Pulchratia symmetrica* var. *regularis* differs from *P. ovalis* (Dunbar & Condra) by being smaller and less elongate in shape. *P. meeki* (Dunbar & Condra) has finer, subequal spines of only one type and *P. symmetrica* (McChesney) is more elongate than var. *regularis*, with greater height, more numerous endospines, a less pronounced reticulate rugosity on the interior of the brachial valve, and lateral slopes that are not as steep posteriorly.

Occurrence.—Rare in the Brush Creek and the Cambridge units.

Type locality.—The Brush Creek limestone at locality Ale-19. The variety is associated with *Antiquatonia portlockiana* var. *crassicostata*?, *Cancrinella boonensis*, *Juresania nebrascensis* var. *pulchra*, *Lino-productus prattenianus*, L. cf. *L. platyumbonus*, *Neospirifer dunbari*, *Composita ovata*, *C. subtilita*, *C. ohioense*, and *Chonetinella plebeia*.

Repository.—Holotype, OSU-25994; paratypes, OSU-25992, 25993, 25995, 25996.

TABLE 11.—Measurements of *P. symmetrica* var. *regularis* n. var. (1-5) from the Brush Creek and *P. cf. P. ovalis* (Dunbar & Condra) (6) from the Ames

	Specimen					
	1	2	3	4	5	6
Arc length (mm)	65	60	51	72	56	72
Width at ears (mm)	27	31	24	31	28	31
Maximum width (mm)	37	35	30	42	33	48
Height (mm)	20	19	17	22	17	22

Pulchratia cf. *P. ovalis* (Dunbar & Condra)

Pl. 15, figs. 18-20

Juresania ovalis Dunbar & Condra, 1932, p. 200-202, pl. 23, figs. 1-4.

Shell medium-sized, suboval, with greatest width near the anterior margin and relatively short hinge line. Pedicle valve with beak tightly incurved over hinge; umbo inflated with steep slopes; ears small; venter of valve flattened; slopes gently rounded, steep; posterior portion rugose, anterior portion lamellose; spines borne on spine ridges and rugae, posteriorly and on ears; and spines arranged in concentric bands anteriorly. Brachial exterior and pedicle interior features not observed.

Brachial interior with strong cardinal process, bilobed anteriorly with a median sulcus, trilobed posteriorly with converging, but not uniting, myophore lobes; median septum narrow, supporting process and extending over half valve length; heavy lateral ridges projecting from process, diverging slightly from hinge; brachial ridges obscure, open proximally; adductors posteriorly dendritic, anteriorly smoother; and numerous endospines in irregular concentric rows. Measurements are given in table 11.

Discussion.—*Pulchratia ovalis* differs from *P. symmetrica* (McChesney) in its broader, more oval, shape. The lamellose character of the anterior portion of the pedicle valve and types and arrangements of spines are probably similar in the two species, although the specimens forming the basis for this description do not show these characters well because of poor preservation.

Occurrence.—Rare in the Ames unit.

Repository.—Hypotypes, OSU-25997, 25998.

Genus *Juresania* Frederiks, 1928

Juresania nebrascensis (Owen)

Pl. 16, figs. 15-21

Productus nebrascensis Owen, 1852, p. 58, pl. 5, fig. 3; Girty, 1915, p. 65-68, pl. 10, figs. 6, 7 (see for synonymy).

[non] *Pustula nebrascensis* Morningstar, 1922, p. 182.

Juresania nebrascensis Dunbar & Condra, 1932, p. 195-198, pl. 22, figs. 1-9, 13; Pederson, 1954, p. 20, pl. 2, fig. 5; Muir-Wood & Cooper, 1960, p. 267, pl. 79, figs. 9-16; pl. 80, figs. 1-10, 12-14; Hoare, 1961, p. 69, 70, pl. 8, figs. 1-6; Fagerstrom & Boellstorff, 1964, p. 23-28, pl. 2, figs. 1-16; Muir-Wood (in Moore, 1965), p. 492, figs. 363, 1a-f.

Shell medium-sized, subquadrate, with greatest width near the anterior margin. Pedicle valve with slightly inflated umbo; beak slightly overhanging hinge; lateral slopes steep; venter medianly flattened;

ears small, not sharply set off from lateral slopes; ornament consisting of rugae posteriorly and concentric bands anteriorly; spines of two diameters borne on rugae posteriorly and on elongated spine ridges on concentric bands anteriorly; and spines also in row along hinge and on ears. Brachial valve flat to gently concave; geniculate; and rugose with erect spines posteriorly and prostrate spines on trail.

Pedicle interior with a pair of small, lightly impressed, dendritic adductor scars; much larger, longitudinally ridged, lightly impressed diductor scars extending farther anteriorly than adductors; numerous small endospines arranged in irregular concentric rows on anterior portion of valve; and rugae, concentric bands, and elongate spine bases reflected on interior surface.

Brachial interior with upright cardinal process consisting of two parallel lobes separated by a conspicuous sulcus, each lobe excavate posteriorly; heavy lateral ridges diverging from process and bordering hinge; distinct alveolus present, bordered by a pair of short, vertical ridges which enclose end of brevisseptum; brevisseptum extends over half valve length; adductor scars elongate-oval ridges, lightly to strongly formed, posteriorly dendritic, anteriorly smooth; numerous endospines arranged in concentric rows near end of brevisseptum, spines smaller and fewer on trail; brachial ridges obscure; and rugose markings reflected on valve interior. Measurements of five specimens are given in table 12.

TABLE 12.—Measurements of *J. nebrascensis* (Owen) from the Brush Creek

	Specimen				
	1	2	3	4	5
Arc length (mm)	53	40	43	33	48
Width at ears (mm)	24	20	26	18	22
Maximum width (mm)	33	25	29	24	30
Height (mm)	16	13	14	9	15

Discussion.—*Juresania nebrascensis* is the most abundant and long-ranging member of this genus found in the Pennsylvanian of Ohio. It differs from *J. rectangularia* R. H. King by being less convex and in having coarser spines and a more quadrate outline. *J. wilberanus* (McChesney) is a much larger, more strongly sulcate species than *J. nebrascensis*. The major problem appears to be the differentiation of species of *Juresania* and *Pulchratia*. Similarity of the external ornamentation of the two genera may cause misidentifications. The major difference lies in the presence, in *Juresania*, of an alveolus, a cardinal process composed of two parallel lobes, and a pair of parallel ridges bordering the alveolus. In *Pulchratia* the alveolus and parallel ridges are absent and the cardinal process is bilobate anteriorly, with a narrow sulcus, and

trilobate posteriorly. Muir-Wood and Cooper (1960) state that the lateral ridges border the hinge in *Juresania* and diverge slightly from the hinge in *Pulchratia*. Numerous specimens of *Juresania* in our collection show slightly divergent lateral ridges. Fagerstrom and Boellstorff (1964) note that the presence or absence of an alveolus and the relative size and impression of the muscle scars on the brachial valve are most useful in differentiating the two genera. From the specimens present it appears that age is a factor in the coalescence of the two parallel lobes of the cardinal process in *Juresania* and also that additional deposits are made along the median septum and muscle scars, deposits which effectively modify the size of the alveolus and the size and impression of the muscle scars. Lengthening of the trail in *Juresania* develops a greater area of lamellose bands anteriorly which causes specimens of this genus to outwardly resemble *Pulchratia*.

Occurrence.—Rare in the Gaysport unit; rare to common in the Cambridge and Putnam Hill units; rare to abundant in the Ames, Brush Creek, Washingtonville, Columbiana, and Vanport units; and abundant in the Skelley unit. Also reported from the Portersville unit by Mark (1912).

Repository.—Hypotypes, OSU-26042 to 26045.

Juresania nebrascensis var. *inflata* n. var.

Pl. 16, figs. 5-9

Shell medium-sized, subquadrate-elongate, with greatest width near the anterior margin. Pedicle valve strongly convex with inflated umbo; beak overhanging hinge; venter flat to faintly sulcate; lateral slopes very steep; ears small; surface rugose with concentric bands anteriorly; and spines borne on rugae and spine ridges, as for species. Internal and external features of the brachial valve the same as for the species. Internal features of the pedicle valve not observed. Measurements of two specimens are given in table 13.

TABLE 13.—Measurements of *J. nebrascensis* var. *inflata* n. var. from the Lower Mercer

	Specimen	
	1	2
Arc length (mm)	58	42
Width at ears (mm)	28	16
Maximum width (mm)	32	22
Height (mm)	18	13

Discussion.—This variety differs from *Juresania nebrascensis* (Owen) by the greater convexity of the pedicle valve, the more strongly inflated umbonal region, and the steeper lateral slopes of the pedicle valve. *J. wilberanus* (McChesney) appears to be a much larger, more strongly sulcate species than var. *inflata*,

and *J. rectangularis* R. H. King is not as elongate and the umbo is not as strongly inflated.

Occurrence.—Rare to common in the Lower and Upper Mercer units. Probably the same as reported by Morningstar (1922) as being rare to common in the Lowellville and Boggs.

Type locality.—The Lower Mercer limestone and shale at locality POa & POd-1. The variety is associated with *Antiquatonia portlockiana* var. *quadrata*, *Kozlowskia haydenensis*, *Desmoinesia* sp., *Punctospirifer kentuckyensis*, *Anthracospirifer rockymontanus*, *Neospirifer goreii*?, *Composita* sp., *Mesolobus obsoletus*, *Mesolobus striatus*, *Rugosochonetes delicatus*, and *Orbiculoidea* sp.

Repository.—Holotype, OSU-26048; paratypes, OSU-26046, 26047.

Juresania nebrascensis var. *pulchra* n. var.

Pl. 16, figs. 10-14

General external characteristics as for the species. Pedicle valve strongly convex, venter flat to slightly sulcate. Brachial valve flat to slightly concave on visceral disc, geniculate.

Internal features of the pedicle valve not observed. Brachial interior with cardinal process as for species; lateral ridges slightly divergent from hinge margin; alveolus distinct; brevisseptum extending over half valve length; adductor scars slightly raised, indistinct; brachial ridges obscure; internal surface marked by a coarse, uniform reticulate pattern formed by external ornamentation; and equally spaced endospines arranged in concentric rows on the reticulations anterior to the brevisseptum. Measurements of five specimens are given in table 14.

TABLE 14.—Measurements of *J. nebrascensis* var. *pulchra* n. var. from the Brush Creek

	Specimen				
	1	2	3	4	5
Arc length (mm)	55	48	45	53	42
Width at ears (mm)	26	26	26	27	24
Maximum width (mm)	34	35	30	34	30
Height (mm)	16	17	15	16	14

Discussion.—This variety differs from *Juresania nebrascensis* (Owen) in having a more strongly convex pedicle valve, in consistently reaching a larger size, and in having uniform internal ornamentation of the brachial valve. *J. nebrascensis* var. *inflata* n. var. is more strongly convex than var. *pulchra*, the reticulation pattern of the brachial valve interior is much finer and less uniform, and the adductor muscle scars are more pronounced. *J. rectangularis* R. H. King has finer spines and, overall, a smaller size.

Occurrence.—Common to abundant in the Brush

Creek unit and rare in the Cambridge and Ames units.

Type locality.—The Brush Creek limestone at locality Ale-19. The variety is associated with *Antiquatonia portlockiana* var. *crassicostata*?, *Cancrinella boonensis*, *Pulchratia symmetrica* var. *regularis*, *Lino-productus prattenianus*, L. cf. *L. platyumbonus*, *Neospirifer dunbari*, *Composita ovata*, *C. subtilita*, *C. ohioense*, and *Chonetinella plebeia*.

Repository.—Holotype, OSU-26050; paratypes, OSU-26049, 27001, 27002.

Genus *Antiquatonia* Miloradovich, 1945

Antiquatonia portlockiana (Norwood & Pratten)

Pl. 11, figs. 8-13

Productus portlockianus Norwood & Pratten, 1855, p. 15, pl. 1, figs. 9a-c.

Dictyoclostus portlockianus Dunbar & Condra, 1932, p. 215-217, pl. 33, figs. 1-3; Hoare & Burgess, 1960, p. 712, 713, pl. 91, fig. 13; [non] Burk, 1954, p. 9, pl. 1, figs. 29, 30.

Antiquatonia cf. *A. portlockiana* Muir-Wood & Cooper, 1960, p. 272, pl. 94, figs. 1-4, 9.

Antiquatonia portlockiana Hoare, 1961, p. 53, 54, pl. 5, figs. 1-7.

Shell medium-sized, subrectangular, with greatest width at the hinge. Pedicle valve with small beak slightly overhanging hinge; ears large; slightly arched, set off by narrow furrow; umbo convex with steep lateral slopes; venter slightly sulcate with steep flanks; surface costellate with costae and costellae enlarged anterior to spine bases; posterior portion crossed by rugae forming reticulate pattern; and spines in row along hinge, in row up flanks on pronounced ridge, and scattered over valve on ribs. Brachial valve slightly concave; geniculate; rugose on visceral disc, costellate on trail; and spines not observed.

Pedicle interior with elongate, slightly raised, dendritic adductor scars; laterally placed, subtrigonal diductor scars, longitudinally grooved and lightly impressed, extending farther anteriorly than adductors; surface reflecting external ornamentation; numerous small endospines on anterior and lateral portions; and ginglymus present.

Brachial interior with sessile cardinal process, median lobe sulcate, lateral lobes excavate and converging dorsally; short lophidium; lateral ridges diverging from hinge at low angle, disappearing before reaching ears; ears set off by prominent ridge in some specimens; median septum broad posteriorly, supporting process, becoming thin and higher anteriorly, extending over half valve length; posterior adductors elongate to subtrigonal, dendritic posteriorly, partially enclosing smaller and smoother anterior adductors; brachial ridges faint; surface reflecting external ornamentation; and numerous rows of endospines anterior to brachial ridges. Measurements of five specimens are given in table 15.

TABLE 15.—Measurements of *A. portlockiana* (Norwood & Pratten) from the Brush Creek

	Specimen				
	1	2	3	4	5
Arc length (mm)	53	45	49	42	49
Width at ears (mm)	42	38	38	36	33
Height (mm)	18	15	16	14	16
Arc length at which last rugae noted (mm)	31	23	27	23	25
Arc length at which sulcus originates (mm)	7	11	14	13	33
Width of sulcus at arc length 40 mm (mm)	8	8	9	8	6
No. of spines on one side of hinge line	4	5	5	3	6
No. of ribs in 10 mm at arc length 30 mm	9	9	10	9	10
No. of ribs in 10 mm at arc length 50 mm	7	-	-	-	-

Discussion.—Differences between *Antiquatonia portlockiana* and *A. costellata* n. sp. are discussed under the latter species. *A. hermosana* (Girty) has a greater length-width ratio, more strongly arched ears, and a more prominent median sulcus than *A. portlockiana* and has an inflated umbo. *A. coloradoensis* (Girty) also has a greater length-width ratio than *A. portlockiana*, is more strongly inflated, and has finer ribs. *A. portlockiana* var. *quadrata* n. var., in the Pottsville Group, is distinct from *A. portlockiana* in the obsolescence of its ribs on the anterior portion of the pedicle valve, and in its more quadrate shape, smaller ears, greater convexity of the pedicle valve, heavier cardinal process, and more strongly developed internal features of both valves.

Occurrence.—Questionably present in the Vanport unit; rare to abundant in the Washingtonville, Brush Creek, Cambridge, and Ames units; rare in the Portersville and Skelley units; and common in the Gaysport unit.

Repository.—Hypotypes, OSU-26011 to 26014.

Antiquatonia portlockiana var. *crassicostata* (Dunbar & Condra)
Pl. 11, figs. 14-21

Productus costatus Mark, 1912, p. 302, pl. 13, fig. 9.
Dictyoclostus portlockianus var. *crassicostatus* Dunbar & Condra, 1932, p. 217, 218, pl. 33, figs. 4-8; pl. 34, figs. 1, 2.

Shell medium-sized with general shape of the species. Pedicle valve thick shelled with inflated umbo strongly recurved over hinge; venter flattened to sulcate, strongly rugose; ears strong, slightly arched, set off from steep flanks by narrow, deep furrows; median sulcus narrow and distinct; costae and costellae large and heavy, especially anterior to spine bases; and spines in a row along hinge, scattered over visceral

disc, in a row up flanks, borne on a heavy ridge, and scattered in an irregular quincunx pattern over anterior portion of the valve. Brachial exterior as for species.

Pedicle interior with raised, suboval adductor scars, strongly dendritic posteriorly, anteriorly less so; large, subtrigonal, longitudinally grooved diductor scars, partially enclosing adductors, and extending farther anteriorly than the latter; no ridge bordering diductor scars; and ginglymus present.

Brachial interior with short cardinal process, trilobate, with median sulcus in middle lobe, lateral lobes curving and converging dorsally; lophidium short, spinelike; lateral ridges diverging from hinge; median septum broad posteriorly, supporting process, narrower and higher anteriorly; brachial ridges not strongly developed; adductor scars dendritic posteriorly, smooth anteriorly; visceral disc rugose; and endospines on ears and anterior to brachial ridges. Measurements of five specimens are given in table 16.

TABLE 16.—Measurements of *A. portlockiana* var. *crassicostata* (Dunbar & Condra) from the Cambridge

	Specimen				
	1	2	3	4	5
Arc length (mm)	63	75	71	52	65
Width at ears (mm)	38	42	40	34?	42
Height (mm)	20	23	23	17	21
Arc length at which last rugae noted (mm)	22	21	27	25	28
Arc length at which sulcus originates (mm)	10	11	13	12	15
Width of sulcus at arc length 40 mm (mm)	7	8	9	10	12
No. of spines on one side of hinge line	4	6	5?	4?	7?
No. of ribs in 10 mm at arc length 30 mm	6	7	8	9	8
No. of ribs in 10 mm at arc length 50 mm	4	5	4	5	5

Discussion.—The variety *crassicostata* differs from *A. portlockiana* (Norwood & Pratten) in the coarseness of the ribs and in the strong enlargement of the ribs anterior to some of the spine bases. Spines are fewer but larger, the umbo more inflated, the sulcus deeper, and the ears larger and more strongly arched in this variety. *A. costellata* n. sp. is much smaller, more finely costellate, and less sulcate, with smaller spines and smaller ears than this variety. Both *A. coloradoensis* (Girty) and *A. hermosa* (Girty) have much finer surface ornamentation than the variety *crassicostata*.

Occurrence.—Rare to abundant in the Brush Creek and Cambridge units.

Repository.—Hypotypes, OSU-26015 to 26019.

Antiquatonia portlockiana var. *quadrata* n. var.

Pl. 15, figs. 1-11

Productus semireticularis Morningstar, 1922, p. 181,

pl. 8, fig. 6.

Productus semireticularis var. *Morningstar*, 1922, p. 181, pl. 8, figs. 4, 5.

Shell medium-sized, subquadrate to subrectangular, with greatest width at the hinge or just anterior to it. Pedicle valve strongly convex, not geniculate; beak slightly overhanging hinge; inflated umbo; flanks steep, set off from small ears by narrow furrow; medianly sulcate; costae and costellae more distinct posteriorly, tending to become obsolescent anteriorly, except anterior to spine bases where they are prominent; visceral disc rugose with a reticulate pattern; and spines in row along hinge, in row up flanks on strong ridge, scattered over rest of valve. Brachial valve slightly concave; geniculate; costae and rugae forming reticulate pattern on visceral disc; and trail costellate.

Pedicle interior with elongate, dendritic adductor scars set on high median ridge; laterally placed, subtriangular diductors are longitudinally grooved and do not extend past adductors; low ridge sets off ears; surface pitted except on ears and along extreme margins where numerous small endospines are present; and ginglymus present.

Brachial interior with heavy sessile cardinal process, median lobe narrow, broadly sulcate, lateral lobes excavate, converging dorsally; lophidium pointed, prominent; brachial ridges diverging from hinge at high angle, curving laterally around visceral disc; median septum supporting process or as a brevisseptum, normally thinner and higher anteriorly, extending over half of valve length; posterior adductors subtrigonal, dendritic; anterior adductors suboval, smoother; brachial ridges prominent, open proximally; and ears, lateral margins, and region anterior to brachial ridges covered with numerous irregular rows of endospines. Measurements of five specimens are given in table 17.

Discussion.—Differences between *Antiquatonia portlockiana* (Norwood & Pratten) and *A. portlockiana*

TABLE 17.—Measurements of *A. portlockiana* var. *quadrata* n. var. from the Lower Mercer

	Specimen				
	1	2	3	4	5
Arc length (mm)	60	65	61	62	60
Width at ears (mm)	38	35	33	40	44
Height (mm)	20	22	21	20	22
Arc length at which last rugae noted (mm)	31	25	31	33	33
Arc length at which sulcus originates (mm)	28	10	10	23	17
Width of sulcus at arc length 40 mm (mm)	11	10	12	14	8
No. of spines on one side of hinge line	5	4	3	2	6
No. of ribs in 10 mm at arc length 30 mm	9	12	10	10	13
No. of ribs in 10 mm at arc length 50 mm	-	-	-	-	-

var. *quadrata* n. var. are discussed under the former species. *A. costellata* n. sp. is a much smaller form than var. *quadrata* with more lightly developed internal features, including less divergent lateral ridges, no strong wrinkle or ridge on the flanks, and a finer costellate ornamentation. *A. hermosana* (Girty) has coarse costae and costellae which do not become obsolete anteriorly. *A. coloradoensis* (Girty) is less convex posteriorly than var. *quadrata* and has more distinct ribs.

Some variation occurs in a population in the degree of obsolescence of the ribs, the convexity of the pedicle valve, and the conspicuousness of the median sulcus. In some cases the ribs are distinct anteriorly and some specimens have a poorly defined sulcus. Specimens with these characteristics approached *A. portlockiana* in external form.

Occurrence.—Rare to common in the Lowellville, Boggs, Upper Mercer, and Vanport units and rare to abundant in the Lower Mercer and Putnam Hill units.

Type locality.—The Lower Mercer limestone and shale at locality Hfg-5. The variety is associated with *Kozlowskia haydenensis*, *Desmoinesia* sp., *Echinaria semipunctata* var. *knighti*, *Juresania nebrascensis*, *Linoproductus planiventralis*, *L. echinatus*, *Derbyia crassa*, *Punctospirifer kentuckyensis*, *Neospirifer gorei*, *Anthracospirifer occiduus*, *Crurithyris planoconvexa*, *Phricodothyris perplexa*, *Composita subtilita*?, *Mesolobus striatus*, *Orbiculoidea* sp., *Lingula carbonaria*, and *Crania modesta*.

Repository.—Holotype, OSU-26020; paratypes, OSU-26021 to 26027.

Antiquatonia costellata n. sp.

Pl. 11, figs. 22-28

Shell medium-sized, subquadrate, with greatest width at the hinge. Pedicle valve with small beak, slightly overhanging hinge; umbo strongly convex with steep slopes; venter flattened with a narrow, shallow sulcus; flanks moderately steep; ears large, set off by narrow furrow; surface uniformly costellate except anterior to spine bases, where costae and costellae are enlarged, and along anterior and lateral margins, where they become obsolete; rugae on posterior portion of shell giving uniform reticulate pattern; and spines in single row along hinge, in row up flanks (but not borne on a prominent ridge), with numerous small spines on umbo and just anterior to umbo in rugose region, and fewer, larger spines borne on ribs and arranged basically in a quincunx pattern anteriorly. Brachial valve gently concave; geniculate; visceral disc rugose; trail costellate; and a few small spines borne on ribs on visceral disc.

Pedicle interior with a thin, low median septum; elongate, tapering adductor scars, dendritic posteriorly; and large, subtriangular, longitudinally ridged adductor scars which enclose adductors.

Brachial interior with internally bilobate and externally trilobate cardinal process; lateral ridges diverging from hinge and disappearing before reaching region of ears; median septum supporting process, becoming much thinner and higher anteriorly, extending over half of valve length; posterior adductor scars dendritic, partially enclosing smoother, subtriangular anterior adductors; brachial ridges not pronounced, open proximally; valve surface reflecting external ornamentation; and region of ears and area anterior to median septum with numerous endospines. Measurements of five specimens are given in table 18.

TABLE 18.—Measurements of *A. costellata* n. sp.
from the Lower Mercer

	Specimen				
	1	2	3	4	5
Arc length (mm)	55	46	41	75	58
Width at ears (mm)	34	27	26	36	38
Height (mm)	17	13	13	23	18
Arc length at which last rugae noted (mm)	24	21	22	26	23
Arc length at which sulcus originates (mm)	20	10	9	17	20
Width of sulcus at arc length 40 mm (mm)	8	6	5	4	10
No. of spines on one side of hinge line	5	7	7	6	5
No. of ribs in 10 mm at arc length 30 mm	16	17	15	15	18

Discussion.—*Antiquatonia costellata* is easily distinguished from *A. portlockiana* (Norwood & Pratten) by its smaller size, finer surface ornamentation, obsolete ribs on lateral and anterior margins, lack of ridge up flanks, and flatter umbonal region. *A. morrowensis* (Mather) is decidedly more convex in the umbonal region than *A. costellata*, has steeper flanks, and has a double row of spines up the flanks. *A. coloradoensis* (Girty) and *A. hermosana* (Girty) are both larger species than *A. costellata* and have spines on a heavy ridge up the flanks, and *A. hermosana* has much coarser ribs which do not become obsolete along the margins.

Occurrence.—Common in the Boggs unit and abundant in the Lower Mercer unit.

Type locality.—The Lower Mercer limestone and shale at locality Vel-6. The species is associated with *Juresania nebrascensis*, *Juresania* sp., *Desmoinesia muricata* var. *missouriensis*, *Krotovia paucispina*, *Echinaria* sp., *Linoproductus planiventralis*, *Linoproductus* sp., *Hustedia mormoni*, *Cleiothyridina orbicularis*, *Derbyia crassa*, *Rhipidomella carbonaria*, *Schizophoria resupinoides*?, *Punctospirifer kentuckyensis*, *Anthracospirifer occiduus*, *A. rockymontanus*?, *Composita subtilita*?, *C. ovata*?, *Plicochonetes dotus*, *Rugosochonetes delicatus*, and *Orbiculoidea missouriensis*.

Repository.—Holotype, OSU-26031, paratypes, OSU-26028 to 26030, 26032.

Genus *Reticulatia* Muir-Wood & Cooper, 1960

Reticulatia huecoensis (R. E. King)

Pl. 16, figs. 1-4

Productus huecoensis R. E. King, 1930, p. 68, pl. 11, figs. 7, 8.

Dictyoclostus newelli R. H. King, 1938, p. 272, 273, pl. 39, figs. 1-4.

Dictyoclostus americana Dunbar & Condra, 1932, p. 218-220, pl. 34, figs. 3-6; Pederson, 1954, p. 20, pl. 2, figs. 20-22.

Reticulatia huecoensis Muir-Wood & Cooper, 1960, p. 284, pl. 104, figs. 1-5; pl. 105, figs. 1-8; Hoare, 1961, p. 50, 51, pl. 5, figs. 8-10; Muir-Wood (in Moore, 1965), p. 496, 497, figs. 367, 1a-e.

Reticulatia americana Branson, 1964, p. 272, 274, pl. 1, figs. 1-4.

Productus semireticularis of American authors in part.

Shell medium to large, subquadrate, with greatest width at the hinge. Pedicle valve with beak slightly overhanging hinge; short ginglymus; ears large, strongly arched; shallow to moderately deep sulcus along median line; flanks steep; surface costellate, 7-10 ribs per 10 mm; posteriorly rugose with conspicuous reticulation; anterior margin of overlapping lamellae formed by successively broken-off trails; spines in a row near hinge, in a row down flanks, and borne on costae in quincunx arrangement; and two rows of spines on specimens with very large ears. Brachial valve with short ginglymus; geniculate; and ornamentation as on pedicle valve, with exception of spines.

Pedicle interior with elongate, raised, medianly-placed adductor scars and posteriorly dendritic, anteriorly smooth and large, longitudinally grooved, triangular diductors in lateral contact with adductors but extending farther anteriorly.

Brachial interior with low, broad cardinal process, anteriorly bilobate, posteriorly trilobate, with lateral lobes uniting on exterior; small lophidium; lateral ridges heavy, diverging slightly from hinge, not extending down lateral margins; median septum supporting process, broad posteriorly, narrow anteriorly; adductor scars large, subtrigonal, dendritic posteriorly, smooth anteriorly; brachial ridges extending laterally, open proximally; and short endospines in concentric rows anteriorly and laterally, coalesced to form fine ridges on trail.

Discussion.—Differences between *Reticulatia huecoensis* and *R. rugatia* n. sp. are given under the latter species. *Dictyoclostus newelli* R. H. King appears to be a synonym of *R. huecoensis*. King's (1938) description follows closely the description by R. E. King (1930) for *Productus huecoensis* and Dunbar and Condra's (1932) description for *Dictyoclostus americana*.

D. newelli is noted as being slightly smaller than *D. americanus* and the latter lacks a distinct sulcus. Specimens of *D. americanus* illustrated by Dunbar and Condra show a distinct sulcus and specimens studied from the Lower Desmoinesian in Missouri commonly have this feature. Number and size of ribs and spines and overall shape being close, *D. newelli* is here placed in synonymy with *R. huecoensis*.

All specimens are fragmentary and crushed, which prevents diagnostic measurements. Approximate sizes may be determined from the illustrated specimens.

Occurrence.—Abundant in the Ames limestone at locality CAC-2.

Repository.—Hypotypes, OSU-26033 to 26036.

Reticulatia rugatia n. sp.

Pl. 14, figs. 10-16

Shell medium-sized, subquadrate, with greatest width at or near the hinge. Pedicle valve strongly convex; small beak prominently overhanging hinge; inflated umbo; lateral slopes steep, set off from small ears by narrow furrow; median sulcus faint; anterior and lateral margins thickened by successively broken-off trails; costae and costellae conspicuous over entire valve, not greatly enlarged anterior to spine bases; rugae forming a reticulate network on the posterior half of valve; and spines in row along hinge, in row up flanks with no heavy ridge (low ridge may be present), and scattered over surface of valve in a quincunx pattern. Brachial valve slightly concave on visceral disc; geniculate with short trail; rugose posteriorly; trail costellate; and spines not observed.

Pedicle interior with elongate adductors, dendritic posteriorly, smoother anteriorly, set on high median ridge; laterally placed, subtrigonal, longitudinally grooved diductors extending anteriorly past adductors; surface irregularly pitted; numerous small endospines present along anterior margin; and ginglymus present.

Brachial interior with broad, sessile cardinal process, interiorly bilobate, externally trilobate, median lobe sulcate, lateral lobes converging and uniting dorsally; lophidium small; brachial ridges diverging from hinge at low angle, not extending to lateral margins but curving anteriorly down sides of visceral disc in some specimens; median septum supporting process, broad posteriorly, thin and higher anteriorly, extending half to two-thirds length of valve; posterior adductors strongly dendritic, smaller anterior adductors lobate, muscle platform subtrigonal in overall shape; brachial ridges prominent, generally closed proximally; and numerous irregular rows of endospines anterior to brachial ridges and on ears. Measurements of four specimens are given in table 19.

Discussion.—*Reticulatia rugatia* is a smaller, more quadrate form than *R. huecoensis* (R. E. King). The latter species has a more rounded venter and more gently sloping flanks than does *R. rugatia*.

Great difficulty is experienced in the differentiation of specimens of *R. rugatia* from specimens of *Antiquatonia portlockiana* (Norwood & Pratten) unless preservation is very good. Generally the presence of broken-off trails on the pedicle valve and the lack of a conspicuous wrinkle or ridge on the flanks can be used for distinguishing specimens of the former species. Normally rugae do not extend as far anteriorly in the species of *Antiquatonia* as they do in forms of *Reticulatia*.

Occurrence.—Rare to abundant in the Putnam Hill, Vanport, and Columbiana units.

Type locality.—The Putnam Hill limestone at locality Me-1. The species is associated with *Desmoinesia muricatina*, *Linoproductus echinatus*?, *Linoproductus* sp., *Composita subtilita*, and *Mesolobus striatus*.

Repository.—Holotype, OSU-26040; paratypes, OSU-26037 to 26039, 26041, 27026.

TABLE 19.—Measurements of *R. rugatia* n. sp. from the Putnam Hill (1, 4) and Columbiana (2, 3)

	Specimen			
	1	2	3	4
Arc length (mm)	73	64	60	66
Width at ears (mm)	39	40	39	44
Height (mm)	23	21	21	20
Arc length at which last rugae noted (mm)	37	33	42	36
Arc length at which sulcus originates (mm)	-	12	19	25
Width of sulcus at arc length 30 mm (mm)	-	8	11	8
No. of spines on one side of hinge line	6	7	5	5
No. of ribs in 10 mm at arc length 30 mm	12	12	11	11
No. of ribs in 10 mm at arc length 50 mm	9	7	7	9

Genus *Linoproductus* Chao, 1927

Linoproductus oklahomae Dunbar & Condra

Pl. 17, figs. 6-8

Linoproductus oklahomae Dunbar & Condra, 1932, p. 251, 252, pl. 44, figs. 1, 2; Muir-Wood & Cooper, 1960, p. 298, pl. 111, figs. 1, 2.

Shell medium-sized, subtrigonal, with greatest width at the hinge line. Pedicle valve with small beak just barely overhanging hinge; umbo moderately arched; flanks gentle and flaring; ears large; venter uniformly rounded posteriorly, forming angular fold anteriorly at arc length 37.0 mm; wrinkles confined to ears and lower lateral slopes; surface costellate, 14-15 ribs per 10 mm; ribs converging on median fold; and spines in a single row along hinge, eight on each side, and borne on costae and costellae in an irregular quincunx pattern. Pedicle interior and brachial interior and exterior not observed.

Discussion.—*Linoproductus oklahomae* differs from all other linoproductids in our collections in its uniformly rounded venter, sharp angular fold anteriorly, and broadly flaring lateral slopes. It is one of the most diagnostic forms of this genus in the Pennsylvanian.

Occurrence.—Rare in the Ames unit.

Repository.—Hypotype, OSU-27003.

Linoproductus planiventralis Hoare

Pl. 16, figs. 22, 23; pl. 17, fig. 13

Linoproductus planiventralis Hoare, 1960, p. 228, pl. 32, figs. 1-3; —, 1961, p. 66, 67, pl. 7, figs. 16, 17; pl. 8, figs. 7-9.

Shell medium-sized, subquadrate, with greatest width at or just anterior to the hinge line. Pedicle valve with small beak incurved over hinge; venter flattened, with steep lateral slopes; ears large, slightly arched; shell strongly wrinkled on ears and lower lateral slopes; surface costellate, 14-16 ribs per 10 mm; and spines borne on costae and costellae in a few specimens, a uniform double row of spines bordering hinge, numbering at least 16 on one side of valve. Brachial valve flat to gently concave over visceral disc; geniculate; marked by costae and costellae and concentric wrinkles; and long trail.

Brachial interior with an internally bilobate cardinal process becoming trilobate externally; lateral ridges paralleling hinge, curving across ears, but not extending down lateral margins; median septum broad posteriorly, where it supports process, thinner anteriorly, extending about half valve length; adductors suboval, dendritic posteriorly, lobed and narrow anteriorly; brachial ridges obscure; and surface reflecting external ribs and wrinkles.

Pedicle interior not observed. None of the specimens are complete enough anteriorly to make diagnostic measurements.

Discussion.—*Linoproductus planiventralis* is the most common form of this genus in the Pottsville units in Ohio. Numerous fragmental specimens, although impossible to identify specifically, appear to belong to this species. The better preserved specimens agree well with those described by Hoare (1960, 1961) from the Seville Limestone in southwestern Missouri. The only other species of *Linoproductus* in the Pottsville Group is *L. echinatus* Hoare, which is found there in minor quantities and is like *L. planiventralis* except it has three rows of spines along the hinge and more numerous spines scattered over the pedicle valve surface. *L. prattenianus* (Norwood & Pratten), which occurs higher in the Pennsylvanian section, closely resembles *L. planiventralis* but differs in having more numerous spines and in not having a flattened venter.

Occurrence.—Rare to abundant in the Lowellville, Boggs, and the Lower Mercer units and rare in the Upper Mercer and Putnam Hill units.

Repository.—Hypotypes, OSU-27004 to 27006.

Linoproductus echinatus Hoare

Pl. 17, figs. 4, 5, 9, 10

Linoproductus echinatus Hoare, 1960, p. 228, 229, pl. 33, figs. 15-19; —, 1961, p. 67, 68, pl. 8, figs. 10-14.

Shell medium-sized, subquadrate, with greatest width at or just anterior to the hinge line. Pedicle valve with small beak incurved over hinge; flattened venter; steep lateral slopes; large ears, slightly arched; costellate, with 16-18 ribs per 10 mm; ears and lower lateral slopes strongly wrinkled; and spines in three irregular rows on ears, numbering up to 26 on one side of shell, and numerous small spines borne on costae and costellae over surface of the valve. Brachial valve gently concave and marked by ribs and concentric wrinkles. Internal features not observed. All specimens crushed and incomplete, preventing diagnostic measurements.

Discussion.—*Linoproductus echinatus* is easily distinguished on the basis of the three rows of spines along the hinge. The number of spines over the pedicle surface is not as great as in *L. missouriensis* (Sayre) and the latter species has only one row of spines along the hinge. *L. prattenianus* (Norwood & Pratten) and *L. platyumbonus* Dunbar & Condra are less spinose than *L. echinatus* and have different shell shapes.

Occurrence.—Rare in the Lower Mercer and Cambridge units and common to abundant in the Washingtonville unit.

Repository.—Hypotypes, OSU-27007, 27008.

Linoproductus cf. *L. magnispinus* Dunbar & Condra

Pl. 17, figs. 11, 12, 14

Linoproductus magnispinus Dunbar & Condra, 1932, p. 244-246; pl. 27, figs. 6-8.

Shell medium-sized and subrectangular. Pedicle valve with small beak, incurved over hinge; umbo strongly inflated; lateral slopes steep; ears large, moderately arched; venter flattened to broadly sulcate; costellate, with 13-15 ribs per 10 mm; and spines in single row along hinge, a few very large spine bases, formed by the coalescence of several costae and costellae on venter, and a few smaller spines on lateral slopes. Exterior of brachial valve and internal features not observed.

Discussion.—Three specimens, partially flattened and incomplete, form the basis for the above description. The size and number of the large spine bases, the convergence of the ribs along the median line, and the single row of spines along the hinge distinguish this form and compare favorably with the same features in illustrations of the species by Dunbar and Condra (1932). The specimens are larger than those described from the midcontinent region and the spines along the hinge are apparently larger in diameter than the corre-

sponding spines in the type specimens.

Occurrence.—Rare in the Cambridge and Ames units.

Repository.—Hypotypes, OSU-27009, 27010.

Linoproductus prattenianus (Norwood & Pratten)

Pl. 17, figs. 1-3

Productus Prattenianus Norwood & Pratten, 1855, p. 17, pl. 1, figs. 10a-d; Meek, 1872, p. 163, pl. 2, figs. 5a-c; pl. 5, fig. 13; pl. 8, figs. 10a, b.

Productus aequicostatus Shumard, 1855, p. 201, pl. C, fig. 10.

Linoproductus prattenianus Dunbar & Condra, 1932, p. 241-244, pl. 24, figs. 4, 5; pl. 27, figs. 1-5, 9; Burk, 1954, p. 9, pl. 1, figs. 36, 37; Hoare & Burgess, 1960, p. 712, pl. 91, figs. 14, 15; Muir-Wood & Cooper, 1960, p. 298, pl. 111, figs. 8, 9; Hoare, 1961, p. 64-66, pl. 7, figs. 10-15; Muir-Wood (in Moore, 1965), p. 500, fig. 373, 2e.

Shell medium-sized, subquadrate to elongate subrectangular, with greatest width at or just anterior to the hinge line. Pedicle valve with small beak sharply incurved over hinge; venter evenly convex to slightly flattened; lateral slopes steep; ears large, moderately arched; surface costellate, 16-20 ribs per 10 mm; ears and lower lateral slopes strongly wrinkled; and spines in double row along hinge, numbering up to 20 on one side of shell, also scattered over venter and flanks. Brachial valve slightly concave; geniculate with long trail; costellate; wrinkled over visceral disc; and no spines observed.

Brachial interior with broad, low cardinal process, tetralobate internally with sulcus in median lobe, lateral lobes curving externally and uniting with median lobe; alveolus shallow or absent; lateral ridges short, diverging slightly from hinge; brevisseptum broad posteriorly, thinner anteriorly, extending near anterior end of visceral disc; adductor scars dendritic, subtrigonal, bordered posteriorly by a pair of low ridges diverging from the region of the alveolus; brachial ridges obscure; and surface reflecting external ornamentation.

Internal features of pedicle valve not observed. Distortion and incompleteness of shells prevents diagnostic measurements.

Discussion.—Differences between this species and *Linoproductus oklahomae* Dunbar & Condra, *L. planiventralis* Hoare, *L. magnispinus* Dunbar & Condra, and *L. echinatus* Hoare are discussed under those species. *L. platyumbonus* Dunbar & Condra has a distinct flattening of the venter or a median sulcus and has fewer spines along the hinge and over the shell surface than does *L. prattenianus*. The ribs on *L. platyumbonus* converge along the median line of the pedicle valve, which is not the case in *L. prattenianus*. *L. prattenianus* is one of the most common species of *Linoproductus* in the Conemaugh Group.

Occurrence.—Rare to abundant in the Ames, Cam-

bridge, and Brush Creek units; rare in the Portersville unit; and questionably present in the Dorr Run and Washingtonville units.

Repository.—Hypotypes, OSU-27011 to 27013.

Linoproductus cf. *L. platyumbonus* Dunbar & Condra
Pl. 10, fig. 21; pl. 17, figs. 15-17

Linoproductus platyumbonus Dunbar & Condra, 1932,
p. 254, 255, pl. 31, figs. 1-5.

Shell medium-sized, subrectangular, with greatest width at or just anterior to the hinge line. Pedicle valve with small beak tightly incurved over hinge; venter flattened to broadly sulcate posteriorly, narrow, low fold anteriorly; lateral slopes steep; ears large, moderately arched; ears and lower lateral slopes wrinkled; surface costellate, 15-18 ribs per 10 mm; and spines in a single row or irregular double row along hinge, numbering up to 12 on one side of shell, and a few small spines on costae and costellae, especially on lateral areas. Features of the brachial valve and pedicle interior not observed.

Discussion.—Numerous specimens, all incomplete, have characteristics somewhat comparable to those of *Linoproductus platyumbonus*. Many are incomplete anteriorly and do not show the angular fold on the pedicle valve. Others have more numerous spines on the valve surface than do specimens described by Dunbar and Condra (1932). The few spines along the hinge and flattened median area posteriorly appear distinctive from the spines of *L. prattenianus* (Norwood & Pratten), which also does not have the anterior fold. The spines in *L. platyumbonus* are much smaller than in *L. magnispinus* Dunbar & Condra and less numerous than in *L. echinatus* Hoare and *L. planiventralis* Hoare. Neither of the latter two species has an anterior fold.

Occurrence.—Rare in the Skelley unit and rare to common in the Gaysport, Ames, and Brush Creek units.

Repository.—Hypotypes, OSU-27014, 27015, 27027.

Genus *Canocrinella* Frederiks, 1928,
emend. Sarycheva, 1937
Canocrinella boonensis (Swallow)
Pl. 11, figs. 1-5

Productus Boonensis Swallow, 1858, p. 217.

Productus cancrini Geinitz, 1866, p. 54, pl. 4, fig. 6.

Productus pertenuis Meek, 1872, p. 164, pl. 1, figs. 14a-c, [non] pl. 8, figs. 9a-d; Drake, 1898, p. 404, pl. 9, figs. 8-10; Beede, 1900, p. 83, pl. 9, figs. 5a-c; Girty, 1903, p. 367.

Pustula pertenuis Mather, 1915, p. 165, 166, pl. 9, figs. 9, 9a; Morningstar, 1922, p. 182, 183, pl. 8, fig. 8.

Canocrinella boonensis Dunbar & Condra, 1932, p. 258-260, pl. 32, figs. 1-5; Muir-Wood & Cooper, 1960, p. 302, pl. 112, figs. 8-13; Muir-Wood (in Moore, 1965), p. 500, 501, figs. 373, 1d-f.

Shell small, suborbicular, with greatest width at approximately mid-length. Pedicle valve with small beak, slightly overhanging hinge; venter convex; flanks moderately steep; ears flat to gently arched; surface costellate with numerous intercalations; rugae extending from ears across venter; and slender spines, recumbent to suberect, borne on ribs, in quincunx arrangement on venter, in groups on ears. Brachial valve concave; costellate; and with concentric rugae. Shell material exfoliated, evidence of pits or dimples not seen. Internal features of valves not observed. Measurements of five specimens are given in table 20.

TABLE 20.—Measurements of *C. boonensis* (Swallow) from the Brush Creek (1-4) and from the Ames (5)

	Specimen				
	1	2	3	4	5
Arc length (mm)	15	17	15	16	13
Width at ears (mm)	15	10	9	10	10
Maximum width (mm)	17	11	10	11	10
Height (mm)	4	6	6	5	4
No. of ribs in 5 mm at arc length 10 mm	12	15	16	16	15

Discussion.—This is the most commonly recognized species of *Canocrinella* in the Pennsylvanian of North America. It differs from *C. altissima* R. H. King in its much smaller size, greater convexity for its size, more numerous spines on the umbonal region, and more conspicuous rugae.

Occurrence.—Rare to abundant in the Brush Creek unit and rare in the Ames unit. Also reported by Morningstar (1922) in the Lowellville, Boggs, and Lower and Upper Mercer units, and by Mark (1912) in the Cambridge, Portersville, and Skelley units.

Repository.—Hypotypes, OSU-27016, 27017, 14108.

Canocrinella sp.
Pl. 11, fig. 6

One medium-sized, flattened, partial specimen, differing from *Canocrinella boonensis* (Swallow). Ribs numbering 7-8 per 5 mm and rugae crossing the venter; spines arranged in concentric rows borne on the rugae; on the venter, spines borne on the ribs are recumbent to suberect. The specimen measures 25.0 mm along the hinge.

Discussion.—This specimen differs from *C. boonensis* (Swallow) in the arrangement of spines on the ears, where the spines are in rows, in the more recumbent and larger spines on the venter, in the larger and less closely spaced ribs, and in the larger size. The rugae are more strongly developed and the spines more irregularly arranged than in *C. altissima* (R. H. King).

Occurrence.—Rare in the Putnam Hill unit.

Repository.—Hypotype, OSU-27018.

Genus *Wellerella* Dunbar & Condra, 1932

Wellerella osagensis (Swallow)

Pl. 10, figs. 1-6

Rhynchonella (*Camarophoria*) *Osagensis* Swallow, 1858, p. 219.

Rhynchonella Osagensis Meek, 1872, p. 179, pl. 1, figs. 9a, b; pl. 6, figs. 2a, b.

Wellerella osagensis Dunbar & Condra, 1932, p. 288, 289, pl. 37, figs. 1-4; [non] Burk, 1954, p. 14, pl. 1, figs. 23-25; Schmidt (*in* Moore, 1965), p. 590, figs. 470, 1g-l.

Wellerella osagensis? Hoare, 1961, p. 32, 33, pl. 4, figs. 6-8.

Shell small, subtriangular to suboval in outline, with greatest width anterior to mid-length, maximum thickness near anterior margin. Brachial valve strongly convex; beak slightly overhanging hinge line; umbo convex, smooth; pronounced fold with three, rarely four, angular costae; and lateral slopes with three to five costae, outer ones obscure. Pedicle valve with high, erect beak; foramen nearly separating deltidial plates, umbo smooth; sulcus pronounced with two, rarely three, angular costae; and lateral slopes with three to five costae, outer ones obscure.

Brachial interior with small, keel-shaped plate between a pair of thin hinge plates; crura extending anteriorly and curving ventrally, becoming V-shaped in anterior portion; and median septum high posteriorly, extending as low ridge approximately one-sixth length of valve. Pedicle interior with short dental plates that curve medianly, reaching floor of valve and extending anteriorly 1.2 mm from beak. Regions between dental plates and valve floor commonly partially filled with secondary deposits (fig. 3).

Measurements on twelve specimens from the Ames limestone at locality JEwa-1 give the following average dimensions: length, 7.1 mm, width, 7.3 mm, and thickness, 4.6 mm.

Discussion.—*Wellerella osagensis* differs from *W. tetrahedra* Dunbar & Condra in having a less pronounced

fold, hence the brachial valve is not as strongly convex, and the shell is not as strongly triangular in shape in a lateral view. The sulcus rounds more strongly to meet the fold in a tongue-like process in the latter species. *W. osagensis* also commonly reaches a larger size than does *W. tetrahedra*. *W. delicatula* Dunbar & Condra is more oval in form than *W. osagensis*, with a lower convexity, and *W. dekalbensis* Dunbar & Condra has six costae on the fold and five in the sulcus.

Occurrence.—Found only in the Ames unit at two localities, JEwa-1, where it is abundant, and Gmo-1, where it is rare.

Repository.—Hypotypes, OSU-27067, 27068.

Wellerella tetrahedra Dunbar & Condra

Pl. 10, figs. 7-9

Pugnax utah Mark, 1912, p. 303, 304, pl. 14, figs. 3, 4.

Pugnax osagensis Girty, 1915, p. 81, pl. 10, figs. 11-11c.

Wellerella tetrahedra Dunbar & Condra, 1932, p. 291, 292, pl. 37, figs. 11-16; Hoare, 1961, p. 31, 32, pl. 4, figs. 1-5; Schmidt (*in* Moore, 1965), p. 590, figs. 470, 1a-f.

Shell small, subtetrahedral in form, with greatest width anterior to mid-length, maximum thickness near mid-length. Brachial valve with small beak; smooth umbo; strongly convex in form; fold prominent with steep lateral slopes; and three subangular costae on fold, two on lateral slopes. Pedicle valve with high beak; smooth umbo; small foramen; prominent sulcus; and two subangular costae in sulcus, two on lateral slopes.

Brachial interior with features similar to those of *W. osagensis*. Pedicle interior features also similar except for broad, high median ridge of secondary material in posterior portion of valve, a ridge which may mark position of adductor muscle attachment (fig. 4).

Dimensions of one complete specimen from the Putnam Hill limestone at locality Mg-5 are: length, 7.8 mm, width, 7.7 mm, and thickness, 5.8 mm.

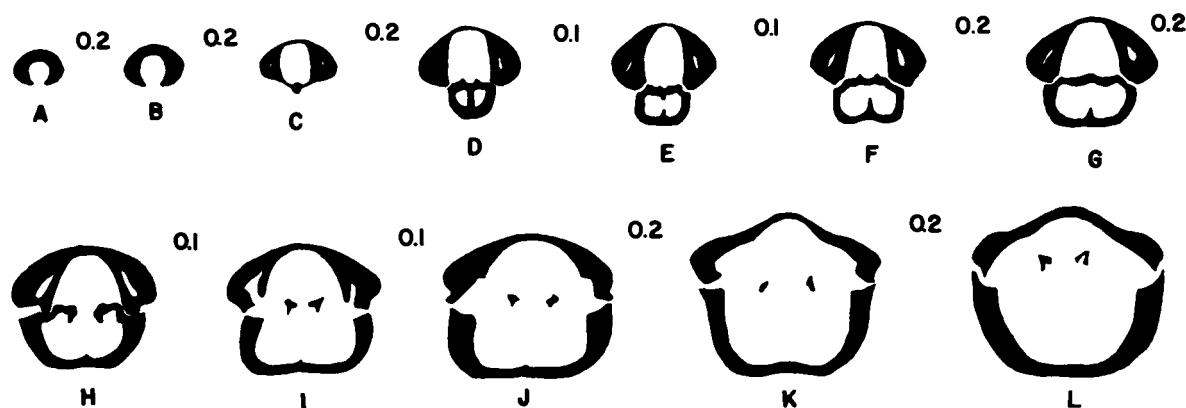


FIGURE 3.—Serial sections of *Wellerella osagensis* (Swallow) from locality JEwa-1; X5. Total length of specimen, 7.0 mm. Numbers indicate distance, in mm, between sections.

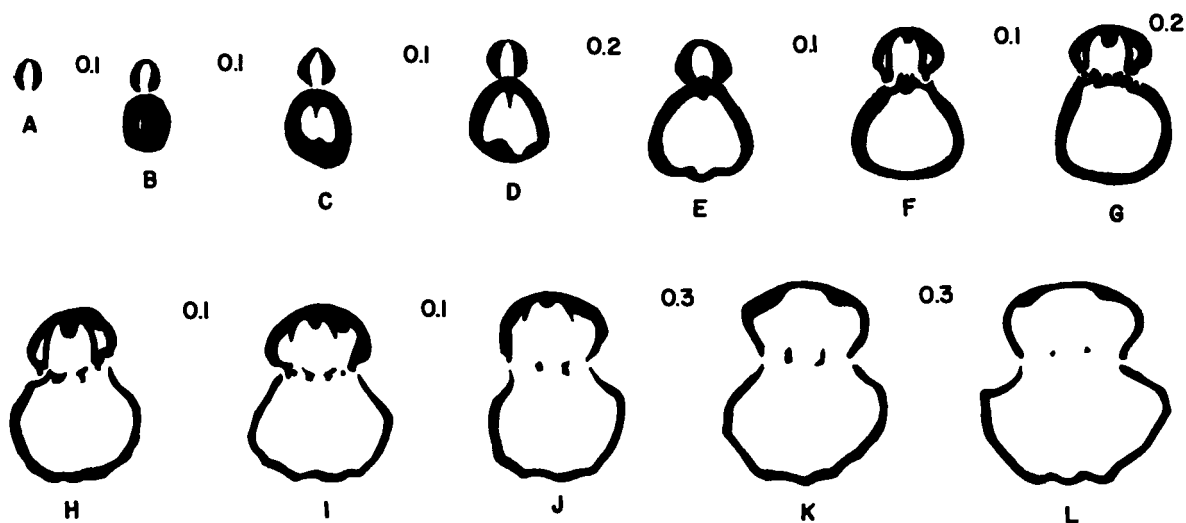


FIGURE 4.—Serial sections of *Wellerella tetrahedra* Dunbar & Condra from locality Tsc-1; X5. Total length of specimen, 6.2 mm. Numbers indicate distance, in mm, between sections.

Discussion.—Differences between *Wellerella tetrahedra* and *W. osagenensis* (Swallow) are discussed under the latter species. *W. delicatula* Dunbar & Condra is a thinner form than *W. tetrahedra* and more oval in shape and *W. dekalbensis* Dunbar & Condra has more numerous costae on the fold and sulcus. Most specimens crushed, preventing specific determinations.

Occurrence.—Rare in the Columbiana, Vanport, and Putnam Hill units.

Repository.—Hypotype, OSU-27069.

Genus *Hustedia* Hall & Clarke, 1893

Hustedia mormoni (Marcou)

Pl. 10, figs. 10-12

Terebratulina mormoni Marcou, 1858, p. 51, pl. 6, figs. 11-11c.

Hustedia mormoni Girty, 1915, p. 103, 104, pl. 12, figs. 5-6a (see for synonymy); Mark, 1912, p. 304, 305, pl. 14, figs. 7, 8; Morningstar, 1922, p. 192, pl. 9, figs. 28, 29; Dunbar & Condra, 1932, p. 356-358, pl. 42, figs. 9-11; Hoare, 1961, p. 86, 87, pl. 11, figs. 12-14; Boucot *et al.* (in Moore, 1965), p. 652, figs. 531, 1a-e.

Shell small, with greatest width near mid-length and greatest thickness posterior to mid-length. Brachial valve with small beak, slightly overhanging hinge line; umbo slightly inflated; greatest convexity just anterior to umbonal area; and subcircular to suboval in outline. Pedicle valve with relatively high beak, perforated by a foramen above a small, longitudinally curved symphytium; greatest convexity posterior to mid-length; elongate-suboval in outline; and some specimens with a very shallow median sulcus. Shell mate-

rial punctate; surface marked by subangular to subrounded costae, 15-17 on brachial valve and 16-18 on pedicle valve.

Brachial interior with flat cardinal process which curves anteriorly, then posteriorly behind pedicle symphytium, bilobate at extreme end; crura bounding sockets and extending into pedicle valve as tapering, elongate processes; single recurved process extending from base of cardinal plate; spiralium of seven volutions; jugal lamellae joining anteroventrally, forming a club-like jugal stem with spines pointing into brachial valve; and median septum short. Pedicle interior with pedicle sheath well developed; teeth flattened; and lacking dental lamellae (fig. 5).

Measurements of fourteen specimens from the Ames limestone and shale at locality Go-1 give the following average dimensions: length, 8.0 mm, width, 7.0 mm, and thickness, 5.6 mm.

Discussion.—*Hustedia mormoni* is the most common form of this genus in the Pennsylvanian of North America. It differs from *H. miseri* Mather by having fewer and larger costae and being more elongate in form. *H. brentwoodensis* Mather is a very narrow form with fewer costae than *H. mormoni* and *H. acuticosta* Newell has fewer and larger costae.

Occurrence.—Rare in the Putnam Hill unit and rare to abundant in the Vanport and Ames units. Also reported from the Cambridge unit by Mark (1912).

Repository.—Hypotypes, OSU-27070, 27071.

Hustedia miseri Mather

Pl. 10, fig. 13

Hustedia miseri Mather, 1915, p. 196, 197, pl. 13, figs. 5-6c, ?4-4c.

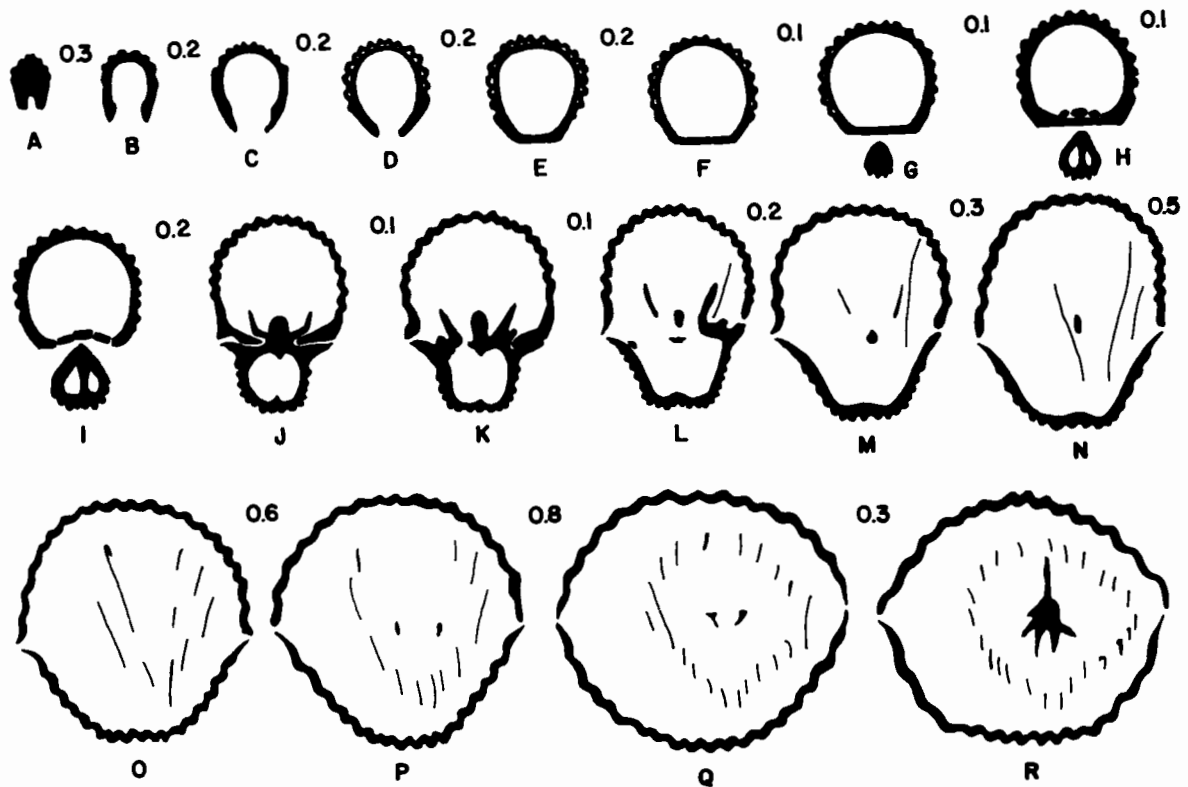


FIGURE 5.—Serial sections of *Hustedia mormoni* (Marcou) from locality Go-1, X5. A distinct pedicle sheath can be seen in sections D-G. Total length of specimen, 9.8 mm. Numbers indicate distance, in mm, between sections.

Shell small, with greatest width near mid-length and greatest convexity posterior to mid-length. Brachial valve suboval; beak small, incurved over hinge line; greatest convexity just anterior to umbonal region; and 19 subrounded costae with intercostal spaces narrower than costae. Pedicle valve elongate suboval; beak arched above small symphytium, perforated by foramen; and 20 costae. Shell material punctate.

Internal features not observed. Dimensions of one partially compressed specimen from the Lower Mercer limestone and shale at locality Vel-6 are: length, 6.7 mm, width, 6.4 mm, and thickness 3.5 mm.

Discussion.—This species differs from *Hustedia mormoni* (Marcou) by having smaller, more numerous costae. *H. brentwoodensis* Mather is a narrower form with fewer costae than *H. miseri* and *H. acuticosta* Newell has fewer and more angular costae.

Occurrence.—Common in the Lower Mercer unit at locality Vel-6 and questionably present in the Boggs unit at locality Tfr-1. Specimens reported by Morningstar (1922) from the Harrison unit may belong to this species.

Repository.—Hypotype, OSU-27072.

Genus *Cleiothyridina* Buckman, 1906
Cleiothyridina orbicularis (McChesney)
 Pl. 10, figs. 14-16

Athyris orbicularis McChesney, 1860, p. 47 (date of imprint, 1859, priv. pub.).

Cleiothyridina orbicularis Girty, 1915, p. 101-103, pl. 12, figs. 2-2c (see for synonymy); Dunbar & Condra, 1932, p. 359-362, pl. 42, figs. 1-4; Hoare, 1961, p. 87, 88, pl. 11, figs. 15-19.

Shell small, with greatest width near mid-length, maximum thickness posterior to mid-length, and valves of near equal convexity. Brachial valve transversely suboval to subcircular; beak small, incurved over hinge line; umbo not inflated; and low, broad median fold present in some specimens. Pedicle valve with low beak tightly incurved over hinge line; foramen small; and faint, shallow median sulcus present in some specimens. Valve surfaces marked by low, fairly broad, concentric lamellae which are divided along their edge into flat, spinelike projections.

Brachial interior with hinge plate perforated by

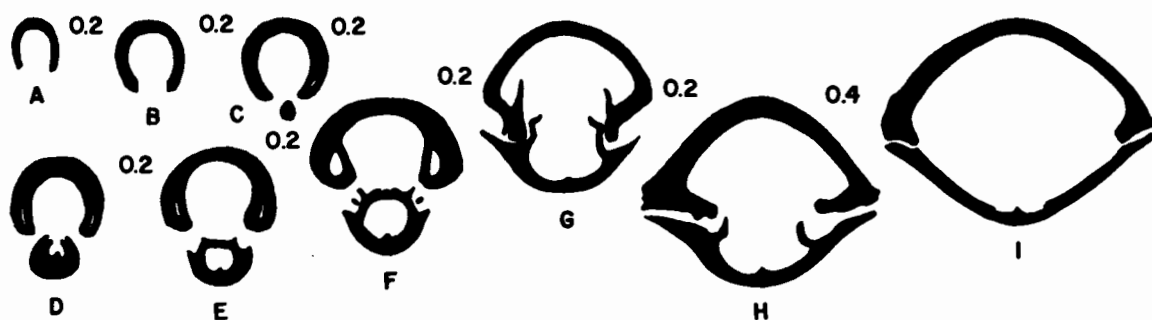


FIGURE 6.—Serial sections of *Cleiothyridina orbicularis* (McChesney) from locality Spk-1; X5. Spiralia missing. Total length of specimen, 9.8 mm. Numbers indicate distance, in mm, between sections.

small foramen; sockets large; crural plates extending from hinge plate, diverging anteriorly; a low, narrow median septum extending from hinge plate about one-third length of valve; and muscle scars not impressed. Pedicle interior with heavy teeth supported by dental lamellae and lightly impressed muscle scars (fig. 6).

Measurements of four specimens from the Washingtonville shale at locality CSu-3 give the following average dimensions: length, 9.7 mm, width, 10.9 mm, and thickness, 6.1 mm.

Discussion.—*Cleiothyridina orbicularis* is the only species of this genus described from the Pennsylvanian of North America. It is a persistent but rather uncommon form in the Pottsville and Allegheny Groups. Difficulty in distinguishing it from immature forms of *Composita* is possible, especially when the surface ornamentation is obscured or removed by weathering. The low, strongly incurved pedicle beak and tendency to a transverse shape are distinctive.

Occurrence.—Rare to common in the Lower Mercer and Putnam Hill units and rare in the Vanport, Columbiana, and Washingtonville units.

Repository.—Hypotype, OSU-27073.

Cleiothyridina orbicularis var. *crassalamellosa* n. var.
Pl. 10, figs. 17, 18; pl. 18, figs. 1-4

Cleiothyridina orbicularis Girty, 1915, p. 101-103, pl. 12, figs. 1-1c, 3-3c.

Shell small to medium, with greatest width at or anterior to mid-length, maximum thickness posterior to mid-length, and valves of near equal convexity. Brachial valve with small beak; umbo not inflated; greatest convexity just anterior to umbonal region; broadly transverse in shape; and in some specimens a low, almost indistinguishable median sulcus. Pedicle valve with low beak, tightly incurved over brachial beak, perforated by small foramen; lateral margins sharply rounded; and a broad, shallow median sulcus commonly present. Valve surfaces marked by broad, concentric lamellae divided into rather coarse, flat, spinelike projections along their anterior margins.

Internal features as for species (fig. 7). Measurements of five specimens from the Lower Mercer limestone and shale at the type locality, Mc-4, give the following average dimensions: length, 12.5 mm, width,

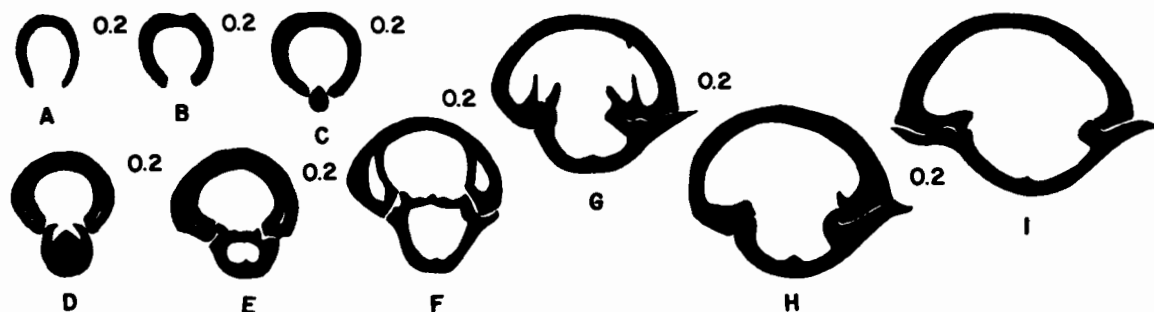


FIGURE 7.—Serial sections of *Cleiothyridina orbicularis* var. *crassalamellosa* n. var. from locality Mc-4; X5. Specimen slightly disoriented, spiralia missing. Total length of specimen, 10.4 mm. Numbers indicate distance, in mm, between sections.

15.7 mm, and thickness, 8.5 mm.

Discussion.—*Cleiothyridina orbicularis* var. *crassalamellosa* differs from *C. orbicularis* (McChesney) by being more transverse in shape and larger and in having a stronger convexity, a somewhat more prominent median sulcus, and coarser spinelike projections from the lamellae. McChesney (1859) did not illustrate or give dimensions of his specimens, a fact which leaves some doubt as to the exact form he was describing. It appears more likely that *C. orbicularis*, being the common form in the Pennsylvanian of Illinois from which his species came, would be the smaller, less transverse form.

Occurrence.—Common from the type locality in the Lower Mercer unit.

Type locality.—The Lower Mercer limestone and shale at locality Mc-4 where the variety occurs with *Phricodothyris perplexa*, *Anthracospirifer rockymontanus*, *Neospirifer* sp., *Kozlowskia haydenensis*, and *Linoproductus* sp.

Repository.—Holotype, OSU-27074; paratype, OSU-27075.

Genus *Composita* Brown, 1849

Composita subtilita (Hall)

Pl. 18, figs. 5-10

Terebratula subtilita Hall, 1852, p. 409, pl. 4, figs. 1a, b, 2a-c.

Composita subtilita Girty, 1915, p. 96-101, pl. 5, fig. 7; pl. 6, fig. 13; pl. 12, figs. 4-4c (see for synonymy); Morningstar, 1922, p. 192, 193, pl. 8, figs. 10-13; Kelly, 1930, p. 147; Dunbar & Condra, 1932, p. 363-366, pl. 43, figs. 7-13; Burk, 1954, p. 12, pl. 1, figs. 5-7, 12; Pederson, 1954, p. 19, pl. 2, fig. 12; Hoare, 1961, p. 89, 90, pl. 11, figs. 20-25, pl. 12, figs. 1, 2; Grinnell & Andrews, 1964, p. 235-237, pl. 37, figs. 3, 4, 7, 10, 11; pl. 38, figs. 1, 2; pl. 39, figs. 3, 4, 9, 10; Boucot et al. (in Moore, 1965), p. 662, figs. 537, 2a-c.

Shell small to medium, with greatest width anterior to mid-length and maximum thickness posterior to mid-length. Brachial valve subovate in outline; moderately convex; beak small; and pronounced fold anteriorly. Pedicle valve with high beak, incurved over brachial beak, terminating in circular foramen; umbonal areas strongly convex; posterolateral margins forming acute angle; and prominent sulcus anteriorly. Surface of valves marked by numerous growth lines.

Brachial interior with subtriangular hinge plate, bordered by vertical lamellae forming inner margin of dental sockets and a pair of small, suboval adjustor muscle scars posterior to dental sockets. Pedicle valve with short, heavy teeth; dental lamellae hanging free beneath teeth or buried in secondary shell material; and a long, narrow adductor scar area bounded by

large, suboval, slightly impressed diductor scars is present. Jugum and number of volutions in spiralia not observed.

Discussion.—*Composita subtilita* is by far the most common species of this genus present in our collections. Although numerous specimens of *Composita* are distorted because of compaction, making their identification questionable, many are probably representative of this species. *C. ovata* Mather is easily confused with *C. subtilita* but can be differentiated when mature by its more ovate shape, lesser convexity, and less pronounced fold and sulcus. *C. argentea* (Shepard) is smaller than *C. subtilita*, broadly ovate, with greatest width near mid-length, and with a less strongly produced fold and sulcus. Intergradations of *C. ovata* and *C. argentea* with *C. subtilita* are not uncommon and they are difficult to differentiate in the youthful growth stages. Results of statistical analyses on several species of *Composita* are given in table 21.

Occurrence.—Rare to abundant in the Ames, Brush Creek, Washingtonville, Columbiana, Vanport, Putnam Hill, and Lower Mercer units and rare in the Zaleski, Upper Mercer, and Boggs units. Also reported from the Harrison, Sharon, and Lowellville units by Morningstar (1922) and from the Cambridge and Portersville units by Mark (1912).

Repository.—Hypotypes, OSU-27076, 27077.

Composita ovata Mather

Pl. 18, figs. 11-18

Composita ovata Mather, 1915, p. 202, pl. 14, figs. 6-6c; Dunbar & Condra, 1932, p. 370, 371, pl. 43, figs. 14-19; [non] Pederson, 1954, p. 19, pl. 2, figs. 6-9; Hoare, 1961, p. 90, 91, pl. 12, figs. 3, 4; Grinnell & Andrews, 1964, p. 234-236, pl. 39, figs. 1, 2, 7, 8.

Composita subtilita var. *ovata* Burk, 1954, p. 12, pl. 1, figs. 2-4, 11.

Shell small to medium, with maximum width near or slightly anterior to mid-length and greatest thickness posterior to mid-length. Brachial valve subovate to subcircular, broadly convex; beak small; and fold low, broad. Pedicle valve moderately convex; beak incurved over brachial beak, terminating in circular foramen; posterolateral margins forming obtuse angle; and sulcus shallow, broad. Surfaces marked only by growth lines. Internal features as in *C. subtilita* (Hall).

Discussion.—*Composita ovata* differs from *C. argentea* (Shepard) by being relatively thinner for its size and in having a less strongly developed fold and sulcus. *C. elongata* Dunbar & Condra is a longer, more strongly convex form than *C. ovata* and *C. ohioensis* n. sp. is relatively thicker, with a greater convexity, and a much stronger fold and sulcus. *C. girtyi* Raymond is smaller and more elongate than *C. ovata*, strongly convex, with well developed fold and sulcus.

TABLE 21.—Statistical characterization of species of the genus *Composita*

Species	Locality	Measurements (mm) ¹										
		N	\bar{L}	\bar{W}	\bar{T}	s_l	s_w	s_t	r_{wl}	r_{wt}	OR _w	D _{wl}
<i>C. subtilita</i>	Go-1	50	16.41	15.41	10.22	3.52	3.62	2.45	.898	.906	7.3-23.9	10.13
<i>C. ovata</i>	Ale-19	15	19.90	19.44	11.70	6.11	5.76	4.55	.983	.937	7.5-27.0	5.56
<i>C. argentea</i>	Vc-6	42	9.77	9.61	6.72	2.83	2.76	2.11	.953	.940	4.8-17.1	8.82
<i>C. magna</i>	Aam-7	7	27.55	26.48	17.00	3.77	5.44	3.48	.950	.708	22.0-35.4	5.47
<i>C. ohioense</i>	Ls-1	50	14.50	14.04	9.32	3.21	2.98	2.22	.979	.933	6.2-19.9	4.44
<i>C. girtyi</i>	Mp-2	30	11.60	10.46	8.41	2.15	1.86	1.61	.923	.744	7.0-15.9	2.15

1. N Number of specimens in sample

 s_t Standard deviation of thickness \bar{L} Mean length r_{wl} Coefficient of correlation of width and length \bar{W} Mean width r_{wt} Coefficient of correlation of width and thickness \bar{T} Mean thicknessOR_w Observed range of width s_l Standard deviation of lengthD_{wl} Coefficient of relative dispersion of width and length measurements around the reduced major axis s_w Standard deviation of width

Occurrence.—Rare to abundant in the Ames and Brush Creek units; rare to common in the Portersville and Washingtonville units; and rare in the Columbiana, Vanport, Putnam Hill, and Lower Mercer units.

Repository.—Hypotypes, OSU-27078 to 27080.

Composita argentea (Shepard)

Pl. 18, figs. 19-24

Terebratula argentea Shepard, 1838, p. 152, fig. 8.

Composita argentea Dunbar & Condra, 1932, p. 367-369, pl. 43, figs. 1-6; Grinnell & Andrews, 1964, p. 235, 236, pl. 37, figs. 1, 2, 8, 9.

Shell small, with greatest width at or near mid-length and greatest thickness posterior to mid-length. Brachial valve with subcircular outline; moderately convex; and with low fold. Pedicle valve moderately convex; posterolateral margins forming obtuse angle; beak low, incurved over brachial beak; and narrow and shallow sulcus. Valve surfaces marked by growth lines. Internal features as for *C. subtilita*, although muscle scars not as strongly impressed.

Discussion.—The differences between *Composita argentea* and other species of *Composita* are given under the latter. As *C. argentea* appears to intergrade with *C. subtilita* (Hall) and *C. ovata* Mather in some collections it is difficult to separate the specimens, especially immature or flattened forms. Undistorted juvenile specimens are most easily distinguished on the basis of shape, form of the beak, and development of the fold and sulcus. In *C. argentea* the juvenile

specimens have a more circular form and a lower beak than does *C. subtilita* and the fold and sulcus is developed earlier than in *C. ovata*.

Occurrence.—Rare to abundant in the Ames, Vanport, and Putnam Hill units. Possibly present in other Allegheny and Conemaugh units.

Repository.—Hypotypes, OSU-27081, 27082.

Composita magna Newell

Pl. 18, figs. 25-30

Composita magna Newell, 1934, p. 431, pl. 53, figs. 5-7; Grinnell & Andrews, 1964, p. 236, pl. 38, figs. 3, 4.

Shell small to medium, with greatest width anterior to mid-length and maximum thickness near mid-length. Brachial valve subovate in shape; moderately to strongly convex; and fold broad and pronounced in anterior half of valve. Pedicle valve moderately to strongly convex; posterolateral margins forming obtuse angle; and broad sulcus. Internal features similar to those of *C. subtilita*.

Discussion.—*Composita magna* is distinguished by its large size. The ovate outline is similar to that of *C. ovata* Mather but the development of fold and sulcus is stronger in *C. magna*. *C. argentea* (Shepard) does not reach the size of *C. magna* and has a stronger convexity at equivalent growth size. *C. subtilita* (Hall) and *C. elongata* Dunbar & Condra are more elongate in shape than *C. magna*; *C. ohioense* n. sp. has a lower beak, maximum width nearer mid-length, and greater

convexity at equivalent size; and *C. girtyi* Raymond is much smaller and more robust, with maximum width near or posterior to mid-length.

Occurrence.—Abundant in the Skelley unit and rare in the Gaysport unit.

Repository.—Hypotypes, OSU-27083, 27084.

Composita elongata Dunbar & Condra
Pl. 19, figs. 1-3

Composita elongata Dunbar & Condra, 1932, p. 371, 372, pl. 43, figs. 20-24; Grinnell & Andrews, 1964, p. 236, pl. 37, figs. 5, 6; pl. 38, figs. 5, 6; pl. 39, figs. 5, 6, 11, 12.

Shell small to medium, with greatest width at or anterior to mid-length and maximum thickness posterior to mid-length. Brachial valve elongate, suboval in shape; strongly convex; and broad, low fold occupying most of width anteriorly. Pedicle valve with high beak, arched over brachial beak; strongly convex; posterolateral margins forming acute angle; and broad, shallow sulcus.

Internal features not observed. Measurements on three specimens, from different localities and horizons, provide the average dimensions: length, 21.6 mm, width, 15.6 mm, and thickness, 12.9 mm.

Discussion.—*Composita elongata* differs from other species of this genus in the Pennsylvanian System by its narrow width and strong convexity in relation to length. Immature forms may be confused with specimens of the genus *Beecheria*, which has a punctate shell, a feature not found in the genus *Composita*. *C. elongata* intergrades with *C. subtilita* (Hall). Only a few specimens of *C. elongata* in our collections can be distinguished with certainty and these generally were not collected in association with *C. subtilita*.

Occurrence.—Rare in the Cambridge, Vanport, and Putnam Hill units.

Repository.—Hypotype, OSU-27085.

Composita ohioense n. sp.
Pl. 19, figs. 4-14

Shell small to medium, with maximum width just anterior to mid-length and maximum thickness at or just posterior to mid-length. Brachial valve suboval to transversely subelliptical in shape; umbo inflated; moderately convex; and with strong fold anteriorly. Pedicle valve moderately convex; beak low and incurved over brachial beak; foramen circular; posterolateral margins forming obtuse angle; and sulcus broad and pronounced on anterior half of valve. Surface marked by growth lines. Internal features as for *C. subtilita*.

Discussion.—*Composita ohioense* differs from *C.*

subtilita (Hall) and *C. elongata* Dunbar & Condra in being much wider for its respective length and in having a lower beak and obtuse posterolateral margins of the pedicle valve. *C. ovata* Mather is not as thick as *C. ohioense* and has relatively less convexity to the valves and a less produced fold and sulcus; *C. argentea* (Shepard) is a relatively smaller species in which the sulcus becomes discernable earlier and is more pronounced at equivalent growth sizes; and *C. girtyi* Raymond is much smaller and has a greater length-width ratio.

Occurrence.—Rare to abundant in the Cambridge unit and common in the Brush Creek unit.

Type locality.—The Cambridge limestone and shale at locality Ls-1. The species is associated with numerous specimens of *Chonetinella flemingi*, *Neospirifer latus*, *Echinaria semipunctata*, *Kozlowskia splendens*, *Antiquatonia portlockiana* var. *crassiradiata*, and *Jurensia nebrascensis*.

Repository.—Holotype, OSU-27086; paratypes, OSU-27087 to 27090.

Composita girtyi Raymond
Pl. 19, figs. 15-20

Composita girtyi Raymond, 1910, p. 152, pl. 28, figs. 1-11.

Shell small, with maximum width at or posterior to mid-length and greatest thickness at or posterior to mid-length. Brachial valve subovate to subpentagonal in shape; moderately to strongly convex; and low, broad fold nearly equal to anterior width. Pedicle valve moderately to strongly convex; posterolateral margins forming acute angle; beak moderately high, incurved over brachial beak; and sulcus shallow and broad. Internal features as for *C. subtilita*.

Discussion.—*Composita girtyi* differs from other species of *Composita* in its greater thickness and convexity at equivalent sizes and in having maximum width posterior to mid-length. *C. argentea* (Shepard) has a thinner, more subcircular form than *C. girtyi* in specimens of the same size. Forms similar to *C. girtyi* are also present in the Loutre facies of the Tiawah Limestone in Missouri.

Forty-four specimens from the repository at the Carnegie Museum provide the basis of comparison with the Ohio specimens. Raymond (1910) did not designate a holotype although the specimens illustrated on his plate 28, figures 6-11, are designated cotypes on the museum label. The specimen illustrated by Raymond on his plate 28, figure 11, is here designated as the lectotype.

Occurrence.—Common to abundant in the Vanport unit and rare in the Putnam Hill unit.

Repository.—Hypotypes, OSU-27091 to 27093.

Genus *Crurithyris* George, 1931
Crurithyris planoconvexa (Shumard)
 Pl. 19, figs. 21-25

- Spirifer plano-convexa* Shumard, 1855, p. 202.
Ambocoelia planiconvexa Girty, 1915, p. 94-96, pl. 11,
 figs. 6-7b (see for synonymy).
Ambocoelia planoconvexa Morningstar, 1922, p. 190;
 Dunbar & Condra, 1932, p. 344-348, pl. 42, figs.
 12-14.
Crurithyris planoconvexa George, 1931, p. 43; Hoare,
 1961, p. 81, 82, pl. 11, figs. 1-3.
Composita ovata Pederson, 1954, p. 19, pl. 2, figs. 6-9.

Shell small, with greatest width at mid-length and maximum thickness at or just anterior to hinge line. Brachial valve with small, very low beak not curved over cardinal area; cardinal area narrowly elongate, triangular in shape, with small, triangular notothyrium bordered by small, flangelike chilidial plates; surface flat or with shallow sulcus anteriorly; and hinge line straight, shorter than maximum width. Pedicle valve

with high beak overhanging cardinal area; umbo inflated with greatest convexity of valve posterior to hinge line; cardinal area broadly triangular with delthyrium bordered by narrow deltidial plates rising as flanges above surface; and valve evenly convex laterally. Surface of valves marked by weak growth lines.

Brachial interior with rounded to oval sockets bounded by socket plates along the hinge line and crural plates projecting above the cardinal area; crural plates continuing anteriorly as low, rounded ridges bounding part of muscle scar field before grading into the initial volutions of the spiralia; cardinal process a low plate between crural plates, in many cases marked by additional deposits of shell material; and muscle scars not impressed. Pedicle valve with short, blunt teeth; secondary deposits partially filling area under beak and apex of delthyrium; and muscle scars lightly impressed (fig. 8).

Measurements of twelve specimens from the Ames limestone at locality JEwa-1 give the following average dimensions: length, 6.9 mm, width, 7.0 mm, and thickness, 4.0 mm.

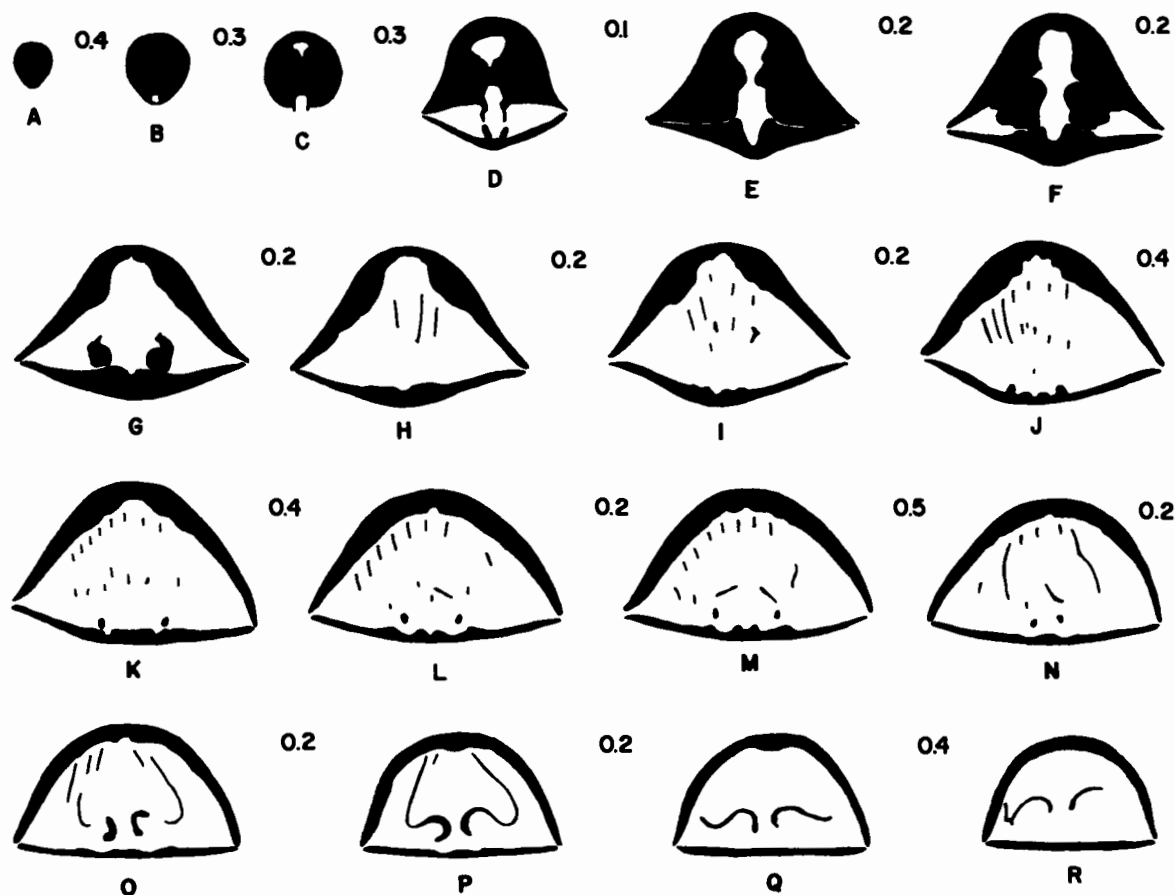


FIGURE 8.—Serial sections of *Crurithyris planoconvexa* (Shumard) from locality Aal-41; X5. Total length of specimen, 5.9 mm. Numbers indicate distance, in mm, between sections.

Discussion.—This is the only species of *Crurithyris* present in our collections from Ohio. *C. expansa* (Dunbar & Condra), from the Wabaunsee Group in Nebraska, is a larger, more transverse form than *C. planoconvexa*, with a lower and more incurved pedicle beak and umbo. *C. lobata* (Girty), from the Shawnee Group of Missouri, also has a lower and more strongly incurved pedicle beak and umbo, and has a pentagonal outline, and a strongly convex brachial valve.

Occurrence.—Rare to abundant in the Gaysport, Ames, Portersville, and Brush Creek units; rare to common in the Washingtonville unit; and rare in the Vanport, Putnam Hill, Upper Mercer, Lower Mercer, and Poverty Run units. Also reported from the Cambridge and Skelley units by Mark (1912).

Repository.—Hypotypes, OSU-27094 to 27096.

Genus *Anthracospirifer* Lane, 1963
Anthracospirifer rockymontanus (Marcou)
 Pl. 19, figs. 26-29

Spirifer rocky-montani Marcou, 1858, p. 50, pl. 7, figs. 4c, d, e, [non] figs. 4, 4a, b.

Spirifer rockymontanus Girty, 1903, p. 383, pl. 6, figs. 4-7c; Dunbar & Condra, 1932, p. 318, 319, pl. 41, figs. 7-9; Hoare, 1961, p. 72, 73, pl. 9, figs. 4-7; Spencer, 1967, p. 15, 16, figs. 9, 2; 10.

Spirifer opimus Morningstar, 1922, p. 188, 189, pl. 9, figs. 13-20.

Shell small, with greatest width anterior to hinge line, cardinal extremities rounded, and lateral margins curving smoothly into anterior margin. Ornamentation weakly ramicostellate. Brachial valve with narrow interarea; small beak; median fold with six strong, subangular costae and costellae; and nine costae and costellae on each lateral slope. Pedicle valve with high, triangular, longitudinally curved interarea; triangular delthyrium with angle of 42° and bordered by narrow dental plates; beak strongly overhanging interarea; sulcus with five costae and costellae; and ten costae and costellae on lateral slopes. Surfaces of valves also marked by very fine, closely spaced, concentric growth lines crossed by very fine, closely spaced, radiating lirae.

Internal features not observed. Measurements of six specimens from several localities give the following average dimensions: length, 12.1 mm, width, 13.9 mm, and thickness, 8.4 mm.

Discussion.—The specimens of *Anthracospirifer rockymontanus* described above compare favorably with specimens described by Dunbar and Condra (1932) and deposited in the repository of the Peabody Museum of Natural History, although the latter specimens, from Missouri and Oklahoma, are slightly larger. The average dimensions noted above are small because several of the specimens are immature.

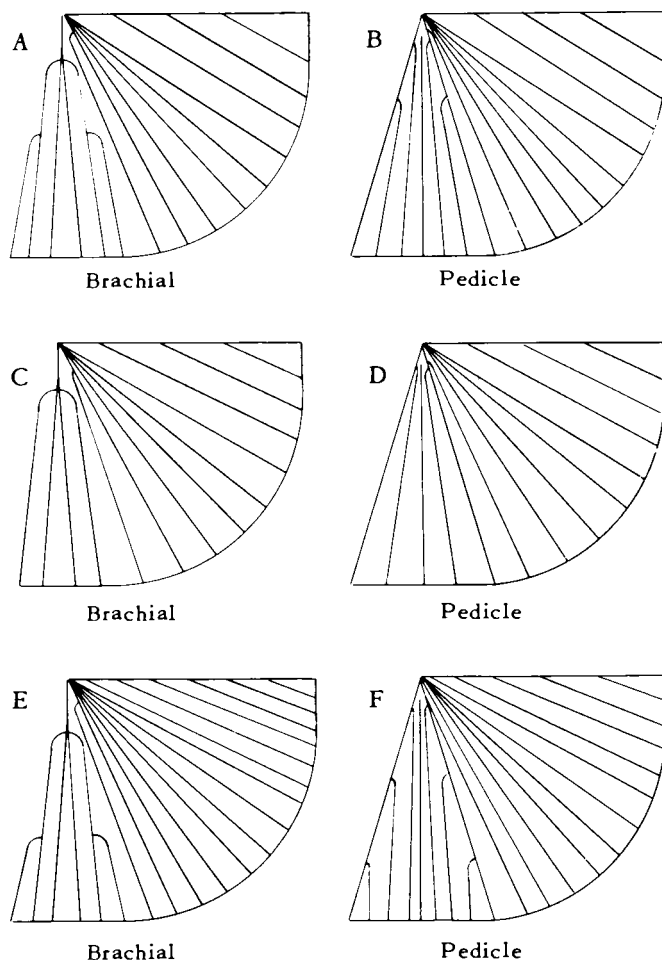


FIGURE 9.—Diagrammatic illustrations of rib patterns. A, B, *Anthracospirifer rockymontanus* (Marcou) from the Putnam Hill; C, D, *A. opimus* (Hall) from the Upper Mercer; and E, F, *A. occiduus* (Sadlick) from the Upper Mercer. (Illustrations of *A. occiduus* not taken from the same specimen.)

A. opimus (Hall) differs from *A. rockymontanus* in having broader and more rounded costae and costellae, of which there are four which are distinct on the fold instead of six, and in having the cardinal extremities more extended. *A. occiduus* (Sadlick) is a more alate form than *A. rockymontanus* and has six costae and costellae on the fold, and those on the lateral areas commonly bifurcate. A diagrammatic representation of the ornamentation pattern of *A. rockymontanus* is given in figure 9A, B.

Occurrence.—Rare in the Upper Mercer and Zaleski units; common in the Boggs unit; and rare to common in the Lower Mercer, Putnam Hill, and Vanport units. Also reported from the Lowellville and Sand Block units by Morningstar (1922).

Repository.—Hypotype, OSU-27097.

Anthracospirifer opimus (Hall)

Pl. 19, figs. 30-32

- Spirifer opimus* Hall, 1858, p. 711, pl. 28, figs. 1a, b; Mather, 1915, p. 185, pl. 12, figs. 7, 7c; [non] Morningstar, 1922, p. 188-190, pl. 9, figs. 13-20; Dunbar & Condra, 1932, p. 320-322, pl. 41, figs. 10-11c; Burk, 1954, p. 11, pl. 1, figs. 16-22; Elias, 1957, p. 515-517, pl. 57, figs. 4, 5; Hoare & Burgess, 1960, p. 713, 714, pl. 91, figs. 4, 5; Hoare, 1961, p. 70, 71, pl. 9, figs. 1-3; Spencer, 1967, p. 16-18, figs. 9, 1; 11.
- Anthracospirifer opimus* Lane, 1963, p. 387, 388; ---, 1964, p. 781-784.

Shell of medium size, with greatest width at or just anterior to hinge line. Lateral margins subparallel, giving subrectangular shape to shell. Ornamentation weakly ramicostellate. Brachial valve with narrow interarea; small beak overhanging interarea; fold with four strong costae and costellae; and lateral slopes with broadly rounded costae and costellae. Pedicle valve with high, longitudinally curved, triangular interarea; delthyrium bordered by narrow dental plates forming angle of 57°; beak and umbo strongly arched over interarea; sulcus with three costae and costellae; and lateral slopes with nine costae and costellae on each. Very fine concentric and radial lirae also ornament the shell surface.

Internal features not observed. Dimensions of one nearly complete specimen are: length, 18.7 mm, width, 23.0 mm, and thickness, 16.0 mm.

Discussion.—A comparison of *Anthracospirifer opimus* and *A. rockymontanus* (Marcou) is given under the latter species. *A. occiduus* (Sadlick) has a more pronounced rectangular shape than *A. opimus*, commonly six costae and costellae on the fold, and a lower pedicle beak and cardinal area.

Although common mention has been made of the presence of four costae and costellae on the fold of *A. opimus*, study of the specimens illustrated by Mather (1915) and by Dunbar and Condra (1932) show six, the outer one on each side being only slightly developed. Representation of the ornamentation pattern of *A. opimus* is shown in figure 9C, D.

Occurrence.—Rare in the Upper Mercer, Zaleski, and Putnam Hill units.

Repository.—Hypotype, OSU-27098.

Anthracospirifer occiduus (Sadlick)

Pl. 20, figs. 1-7

- ?*Spirifer boonensis* Swallow, 1860, p. 646.
- Spirifer boonensis*? Girty, 1903, p. 381, pl. 6, figs. 1-3; Morningstar, 1922, p. 186, pl. 9, figs. 21-25.
- Spirifer opimus* var. *occidentalis* Girty, 1927, p. 433, pl. 27, figs. 28-31.
- Spirifer occidentalis* Dunbar & Condra, 1932, p. 322-

326, pl. 41, figs. 12-16; Foster, 1942, p. 249, 250, text-fig. 1.

Spirifer occiduus Sadlick, 1960, p. 1210-1214; Hoare, 1961, p. 73, 74, pl. 9, figs. 8-10; Spencer, 1967, p. 18-20, figs. 9, 3; 12.

Anthracospirifer occiduus Lane, 1963, p. 387, 388; ---, 1964, p. 781-784.

Shell small to medium, with greatest width at hinge line. Subrectangular in shape, with lateral margins parallel to slightly converging anteriorly. Ornamentation weakly ramicostellate. Brachial valve with narrowly elongate interarea; beak small; fold with six broadly rounded costae and costellae; and lateral slopes with 10-12 costae and costellae each. Pedicle valve with elongate, triangular, moderately curved interarea; delthyrium bordered by narrow dental plates forming angle of 56-63°; beak moderately high and incurved; sulcus with five costae and costellae; and lateral slopes with 11-12 costae and costellae each. Valve surfaces also marked by fine, closely spaced, concentric and radial lirae.

Brachial interior with small, triangular dental sockets; small, vertically marked cardinal process; and a low median septum reaching near mid-length. Pedicle valve with dental lamellae reaching floor of valve posteriorly; beak area filled with callus; two low, ridge-like adductor scars projecting anteriorly, bordering a median groove; and diductor scars impressed, elongate-oval, bordered on outside by dental lamellae and ridges extending from lamellae.

All specimens compressed or fragmental, preventing diagnostic measurements. Relative relationships can be seen in illustrations of internal mold (pl. 20, figs. 4-7).

Discussion.—Comparisons of *Anthracospirifer occiduus* with *A. opimus* (Hall) and *A. rockymontanus* (Marcou) are given under the latter discussions. Diagrammatic representation of the ornamentation pattern of *A. occiduus* is given in figure 9E, F.

There is some possibility of misidentification, especially as *A. rockymontanus*, because of the compressed nature of most of the specimens. The broader and more rounded costae and costellae and the presence of a lower beak are diagnostic. *A. rockymontanus*, when compressed, has the height of the beak accentuated.

Occurrence.—Common in the Poverty Run, Zaleski, and Vanport units; common to abundant in the Upper Mercer unit; rare to abundant in the Lower Mercer and Putnam Hill units; and abundant in the Boggs unit.

Repository.—Hypotypes, OSU-27099 to 27102.

Genus *Neospirifer* Frederiks, 1919*Neospirifer dunbari* R. H. King

Pl. 20, figs. 8-15

Spirifer triplicata Hall, 1852, p. 410; Girty, 1920, p.

655, pl. 54, fig. 22.

Neospirifer triplicatus Dunbar & Condra, 1932, p. 328-332, pl. 39, fig. 5; pl. 41, figs. 1-6.

Neospirifer dunbari R. H. King, 1933, p. 441.

Neospirifer dunbari dunbari Spencer, 1967, p. 22, 23, figs. 13, 3; 14.

Shell medium to large, with greatest width at the hinge line. Cardinal extremities commonly produced, with lateral margins converging anteriorly. Convexity of valves nearly equal. Brachial valve with small beak slightly overhanging very narrow interarea; median fold strong; and lateral slopes gently convex. Pedicle valve with elongate, slightly tapering interarea; large, triangular delthyrium forming angle of approximately 70° with narrow dental plates; beak overhanging interarea; sulcus strongly developed, terminating in tongue-like structure at anterior margin; and lateral slopes flat to gently concave. Ornamentation fascicostellate on both valves; brachial valve with 8-12 costae and costellae on fold and 15-22 on each lateral slope; pedicle valve with 9-13 costae and costellae in sulcus and 17-24 on each lateral slope; and moderate variation in rib pattern.

Brachial interior with crural lamellae attached to strong socket plates and hanging free below; sockets elongate, radiating from beak; socket plates supporting a small hinge plate; cardinal process low and longitudinally grooved; and low, thin median septum extending from hinge plate anteriorly. Muscle scars not observed. Pedicle interior with heavy callus under beak, partially filling apex of delthyrium; low, thin median septum protruding from under callus, extending to mid-length; stout teeth at end of dental plates; and dental lamellae resting on floor of valve, outlining posterior portion of elongate, oval muscle scars.

Measurements of six specimens from the Ames limestone and shale at locality Go-1 give the following average dimensions: length, 26.9 mm, width, 40.0 mm, and thickness, 19.1 mm.

Discussion.—*Neospirifer dunbari* differs from *N. latus* by being less transverse in shape and having fewer and less strongly developed costae and costellae throughout the shell. In *N. cameratus* the costae and costellae are broader and not bundled as in *N. dunbari*. *N. goreii* has costae and costellae which are not as strongly bundled as those of *N. dunbari* and the sulcus and fold are not as strongly developed. *N. kansasensis* has more numerous costae and costellae on sulcus, fold, and lateral slopes.

There is a considerable amount of variation in the number and arrangement of bifurcation of the costae and costellae in *N. dunbari*. Figure 10 gives a diagrammatic representation of the rib patterns of two different specimens from different stratigraphic positions. The amount of variation appears as great within a single population as it is between populations from different stratigraphic positions. In some instances forms ap-

proaching *N. latus* are present. No forms referable to *N. dunbari* var. *alatus* were encountered in these collections.

Occurrence.—Rare to abundant in the Ames and Brush Creek units; common in the Cambridge and Skelley units; and rare in the Gaysport unit.

Repository.—Hypotypes, OSU-27103 to 27105.

Neospirifer latus Dunbar & Condra
Pl. 20, figs. 16, 17; pl. 21, figs. 1-4

Neospirifer latus Dunbar & Condra, 1932, p. 336-337, pl. 40, figs. 1-5.

Neospirifer latus latus Spencer, 1967, p. 26-28, figs. 18, 1; 19.

Shell large, with greatest width at hinge line. Cardinal extremities commonly extended; lateral margins convex to straight, converging toward anterior margin; valves moderately to strongly convex; and lateral slopes broad, gently convex to slightly concave. Brachial valve with narrow, slightly tapering interarea; beak small, hanging over interarea slightly; and fold broadly rounded to subangular. Pedicle valve with wide, slightly tapering interarea; large, triangular delthyrium with angle of 55° and partially filled with callus; narrow dental plates bordering delthyrium; and sulcus broadly rounded to subangular. Surface of both valves fascicostellate; brachial valve with 10-14 costae and costellae on fold; pedicle valve with 11-15 in sulcus; and costae and costellae normally strongly developed and bundled on lateral slopes, with as many as 29 on each lateral slope.

Brachial interior with fairly long, gradually widening dental sockets set off by strong socket plates; crural lamellae supporting socket plates and hanging as flanges below them; a short hinge plate with a low cardinal process which is finely grooved longitudinally; and a low, narrow median septum extending to approximately mid-length of valve. Pedicle interior with heavy callus partially filling apex of delthyrium; low, narrow median septum extending anteriorly from under callus, bordered by a pair of low ridges or septa which form inner margin of muscle scars; dental lamellae resting on floor of valve, enclosing posterior portion of muscle scars, but hanging as flanges under dental plates and teeth anteriorly; and muscle scars large, subtriangular in shape.

Specimens normally compressed or fragmental. Maximum length observed, 35.7 mm, and maximum width observed, 84.2 mm.

Discussion.—*Neospirifer latus* differs from *N. dunbari* by being more transverse in outline, in having more costae and costellae to encompass the larger size, and in having costae and costellae bifurcating in more places and, in most instances, being more strongly bundled. Variations in the latter feature do occur and in some specimens the bundling is no more

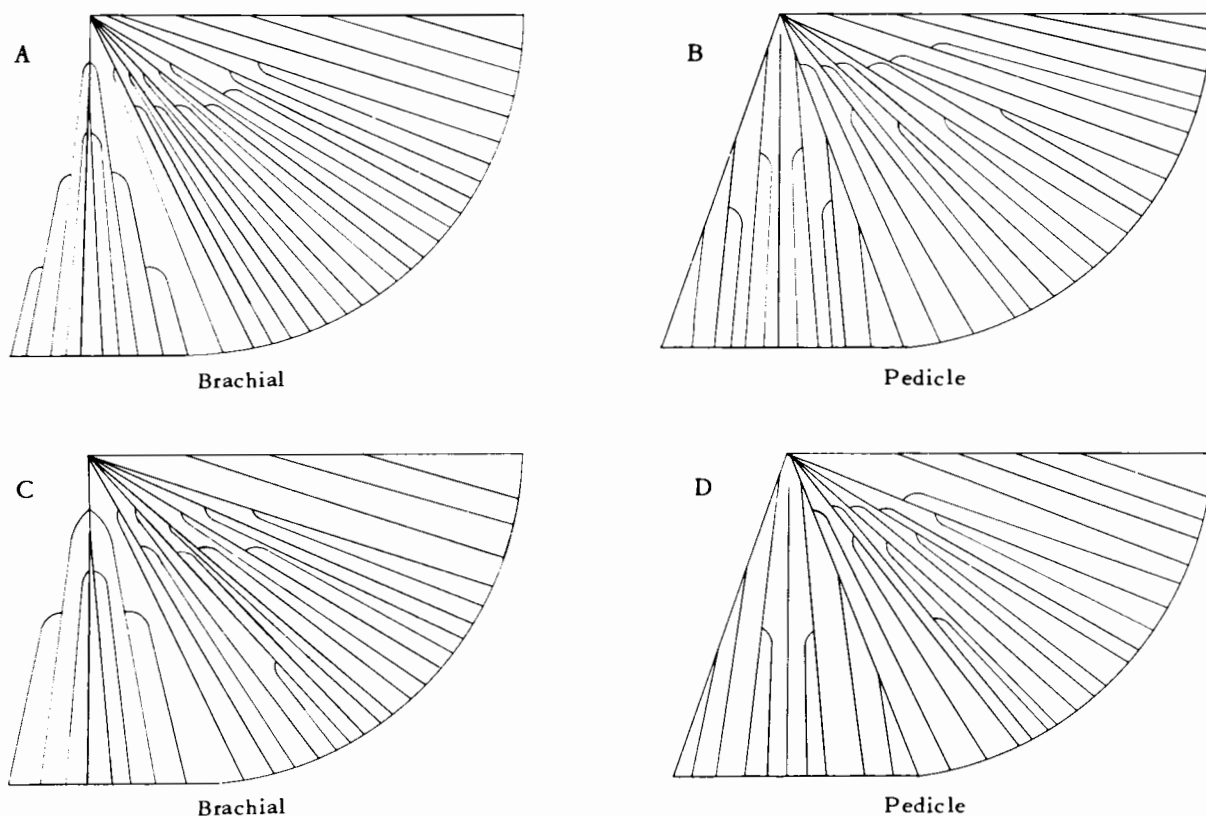


FIGURE 10.—Diagrammatic illustrations of the rib pattern of *Neospirifer dunbari* R. H. King. A, B, from the Ames; and C, D, from the Brush Creek.

pronounced than in *N. dunbari*. *N. kansasensis* has finer and more numerous costae and costellae than *N. latus*. A diagrammatic representation of the rib pattern is given in figure 11A, B.

Occurrence.—Rare to abundant in the Brush Creek, Cambridge, and Portersville units; rare in the Columbiana unit; and questionably present in the Gaysport unit.

Repository.—Hypotypes, OSU-27106 to 27108.

Neospirifer cameratus (Morton)

Pl. 21, figs. 5-8

Spirifer cameratus Morton, 1836, p. 150, pl. 2, fig. 3; Girty, 1915, p. 87-91, pl. 9, figs. 4-4b (see for synonymy); —, 1920, p. 645; [non] Mark, 1912, p. 304, pl. 14, figs. 1, 2; [non] Morningstar, 1922, pl. 9, figs. 11, 12; Girty, 1927, p. 434, pl. 27, figs. 24-27; Kelly, 1930, p. 147, pl. 11, fig. 17.

Neospirifer cameratus Dunbar & Condra, 1932, p. 334-336, pl. 39, figs. 4, 6-9b; Hoare & Burgess, 1960, p. 714, pl. 91, fig. 9; Hoare, 1961, p. 76-78, pl. 9, figs. 15-17; pl. 10, figs. 1, 2; Pitrat (in Moore, 1965), p. 706, figs. 573, 4b-c; Spencer,

1967, p. 25, 26, figs. 9, 4; 17.

Spirifer (*Neospirifer*) *cameratus* Dresser, 1954, p. 57-61, pl. 5, fig. 11; pl. 7, figs. 7-11.

Shell medium to large, with greatest width at or just anterior to hinge line. Cardinal extremities rounded, right-angled, or slightly produced. Both valves moderately convex with lateral slopes convex. Brachial valve with narrowly tapering interarea; slightly overhanging beak; and fold slightly to moderately produced. Pedicle valve with broad, slightly tapered interarea; delthyrium large, triangular, with angle of approximately 60°, bordered by narrow dental plates; beak overhanging hinge line; and sulcus moderately developed, ending anteriorly in a broad, tonguelike structure. Valve surfaces ramicostellate with costae and costellae broad and rounded but not bundled; 10-12 costae and costellae on fold, 9-11 in sulcus, and up to 25 on lateral slopes; and very fine and closely spaced concentric lirae crossed by finer radiating lirae.

Internal features not observed. Measurements of eight specimens from several localities give the following average dimensions: length, 31.4 mm, width, 44.6 mm, and thickness 22.8 mm.

Discussion.—*Neospirifer cameratus* has a relatively

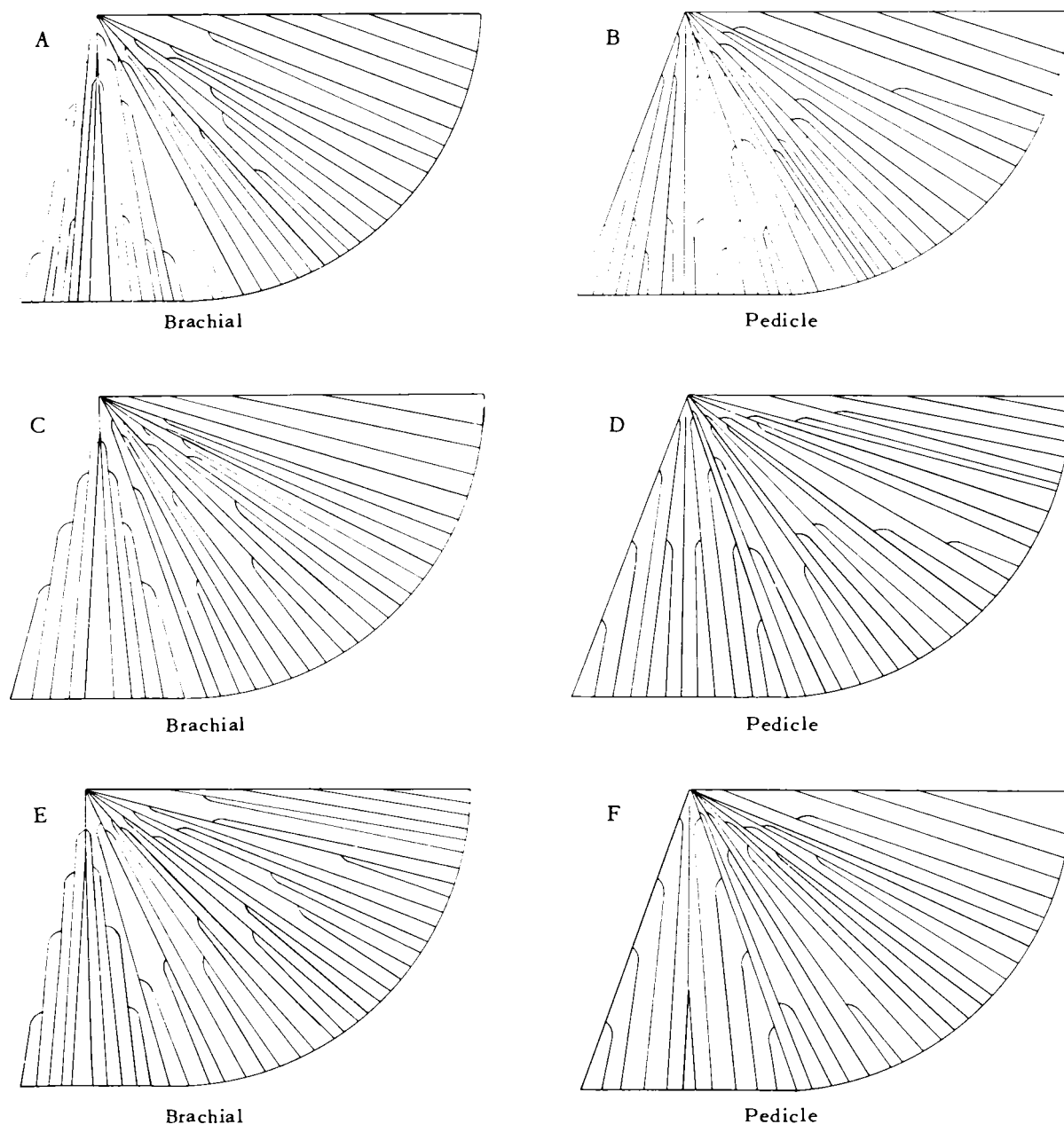


FIGURE 11.—Diagrammatic illustrations of rib patterns. A, B, *Neospirifer latus* Dunbar & Condra from the Portersville; C, D, *N. cameratus* (Morton) from the Putnam Hill; and E, F, *N. goreii* (Mather) from the Lower Mercer. (Illustrations of *N. goreii* not taken from the same specimen.)

broader and lower fold than do *N. dunbari* and *N. latus*. The cardinal extremities are less produced and the surface ramicostellate instead of fascicostellate as in the latter two species. *N. goreii* is similar in appearance to *N. cameratus*, although it bears more abundant and more angular costae and costellae. Diagrammatic representation of the surface ornamentation is given in figure 11C, D.

Morton's original description was apparently based upon specimens from the Vanport limestone at Putnam Hill, Zanesville, Ohio. Specimens from the Putnam Hill units at this locality and from the Vanport and Putnam Hill units elsewhere agree closely with Girty's (1915a) and Dunbar and Condra's (1932) specimens.

Occurrence.—Rare to abundant in the Putnam Hill unit; rare to common in the Columbiana and Upper

Mercer units; and rare in the Vanport and Lower Mercer units. Also reported from the Brush Creek, Cambridge, Portersville, Ames, and Skelley units by Mark (1912), but specimens from those units are probably occurrences of *N. latus* and *N. dunbari*.

Repository.—Hypotypes, OSU-27109, 27110.

Neospirifer goreii (Mather)

Pl. 21, figs. 9-12

Spirifer goreii Mather, 1915, p. 186, pl. 12, figs. 10-11a.

Neospirifer goreii Dunbar & Condra, 1932, p. 341, 342, pl. 39, figs. 1-3; Hoare, 1961, p. 74, 75, pl. 9, figs. 11-13; Spencer, 1967, p. 32, 33, figs. 7, 2; 22.

Shell medium to large, with greatest width at hinge line. Valves not strongly convex, with lateral margins converging rapidly on anterior margin. Brachial valve with beak slightly overhanging narrow interarea; fold low; and anterior margin only slightly sinuate. Pedicle valve with beak strongly overhanging a fairly wide, slightly tapering cardinal area; delthyrium partially filled with callus; narrow dental plates forming angle of about 40°; and sulcus broad and shallow. Both valves ramicostellate, with costae and costellae rounded to subangular; 8 costae and costellae in sulcus, 10 on fold; 20-28 on lateral slopes, number dependent upon size and degree of alateness; and fine, radiating lirae and growth lines present.

Internal features not observed. Specimens not complete enough for diagnostic measurements.

Discussion.—*Neospirifer goreii* is most easily confused with *N. cameratus*, the only major difference being the more numerous costae and costellae on *N. goreii*. The costae and costellae on the specimens described above number 11-13 per cm on the lateral slopes at a distance of 2 cm from the pedicle beak. *N. cameratus* has 7-8 costae and costellae in the same area. As in *N. cameratus*, the costae and costellae, although bifurcating, are not bundled, which helps to differentiate *N. goreii* from *N. dunbari* and *N. latus*. Diagrammatic representations of the rib pattern are given in figure 11E, F.

Occurrence.—Rare in the Lower Mercer, Upper Mercer, and Putnam Hill units.

Repository.—Hypotypes, OSU-27111 to 27114.

Genus *Punctospirifer* North, 1920

Punctospirifer kentuckyensis (Shumard)

Pl. 22, figs. 1-4

Spirifer Kentuckyensis Shumard, 1855, p. 203.

Spiriferina kentuckyensis Girty, 1915, p. 85-87, pl. 11, figs. 8, 8a (see for synonymy); Morningstar, 1922, p. 186.

Punctospirifer kentuckyensis Dunbar & Condra, 1932,

p. 351-355, pl. 38, figs. 1-5; Elias, 1957, p. 518, pl. 57, fig. 1; Hoare, 1961, p. 84-86, pl. 11, figs. 7-11; Spencer, 1967, p. 14, 15, figs. 7, 1; 8.

Shell small to medium, with greatest width at hinge line. Shell material coarsely punctate. Lateral margins rectangular to strongly produced. Brachial valve with narrow interarea; small beak, slightly overhanging interarea; median fold with distinct, low median plication; each lateral slope with 6-12 equally spaced costae, number dependent upon degree of alateness of shell; and surface marked by closely spaced, 5-7 per mm, concentric, imbricating lamellae. Pedicle valve with small beak, slightly overhanging narrowly triangular interarea; delthyrium triangular, forming angle of 37°, with narrow dental plates; median sulcus with a distinct, low median plication; and lateral slopes with costae and imbricating lamellae as on brachial valve.

Interior of brachial valve with a thin, low median septum extending anteriorly from base of short hinge plate; crural lamellae hanging as flanges from inner edge of hinge plate; cardinal process low, subquadrate, with four subequal lobes posteriorly; inner socket plates strongly developed; and a pair of slightly curved septa following the inner margins of the median plicae. Spiralia and interior features of pedicle valve not observed. All specimens crushed or incomplete, preventing diagnostic measurements.

Discussion.—*Punctospirifer kentuckyensis* is not easily confused with other described species of this genus from North America. Differences in surface ornamentation and relative size of costae are distinctive. Other described species of this genus lack the external imbricating lamellae of *P. kentuckyensis*. A large amount of variation exists in the relative length-width ratio, as illustrated on plate 22, figures 1-4. The number of costae increases with the alateness of the shell. Differences between *P. kentuckyensis* and the new variety *amesi* are discussed under the latter.

Occurrence.—Rare in the Poverty Run, Upper Mercer, Vanport, and Washingtonville units; and rare to abundant in the Lower Mercer and the Putnam Hill units. Also reported from the Harrison, Sharon, and Upper Mercer units by Morningstar (1922).

Repository.—Hypotypes, OSU-27115, 27116.

Punctospirifer kentuckyensis var. *amesi* n. var.

Pl. 22, figs. 5-9

Shell shape and size in general similar to shape and size of the species. Differing externally from the species in being more robust in form and in having slightly fewer costae on the lateral slopes in equivalent sized specimens. Concentric imbricating lamellae strongly developed. Low costellae at the median line of fold, and sulcus lacking.

Brachial interior features as for species. Spiralia

with at least ten volutions. Pedicle interior with high, narrow median septum extending to near mid-length of valve; teeth large, supported by strong dental plates extending to floor of valve (fig. 12).

Measurements on six specimens from the type locality, Go-1, give the following average dimensions: length, 7.6 mm, width, 13.1 mm, and thickness, 7.1 mm.

Discussion.—A comparison of specimens of *Punctospirifer* from Ohio with the specimens used for illustration by Dunbar and Condra (1932) and with other specimens from the Desmoinesian of Missouri was made. All of the comparative material from the Western Interior basin present had ornamentation similar to that of the specimens from the Pottsville and Lower Allegheny Groups of Ohio. Especially noteworthy is the presence on the fold and sulcus of low median costellae, described by Dunbar and Condra (1932, p. 352) as narrow depressed lines and narrow elevations. All of the specimens present in the collections from the Ames limestone and shale lack these median markings. The costae are more robust and the growth lamellae heavier than in the specimens lower in the section.

Occurrence.—Rare to abundant in the Ames limestone and shale. Specimens reported from the Brush Creek, Cambridge, and Portersville units by Mark (1912) may belong here.

Type locality.—The Ames limestone and shale at locality Go-1. The variety is associated with numerous specimens of *Neospirifer dunbari*, *Linoproductus* cf. *L. platyumbonus*, *Juresania nebrascensis*, *Composita subtilita*, *Neochonetes granulifer*, *Derbyia parvicostata*, and crinoid plates and columnals.

Repository.—Holotype, OSU-27117; paratype, OSU-27118.

Genus *Phricodothyris* George, 1932

Phricodothyris perplexa (McChesney)

Pl. 22, figs. 10-14

Spirifer perplexa McChesney, 1860, p. 43.

Squamularia perplexa Girty, 1915, p. 92-94, pl. 11, figs. 1-3a (see for synonymy); Morningstar, 1922, p. 191, pl. 9, figs. 26, 27.

Squamularia? perplexa Dunbar & Condra, 1932, p. 313-

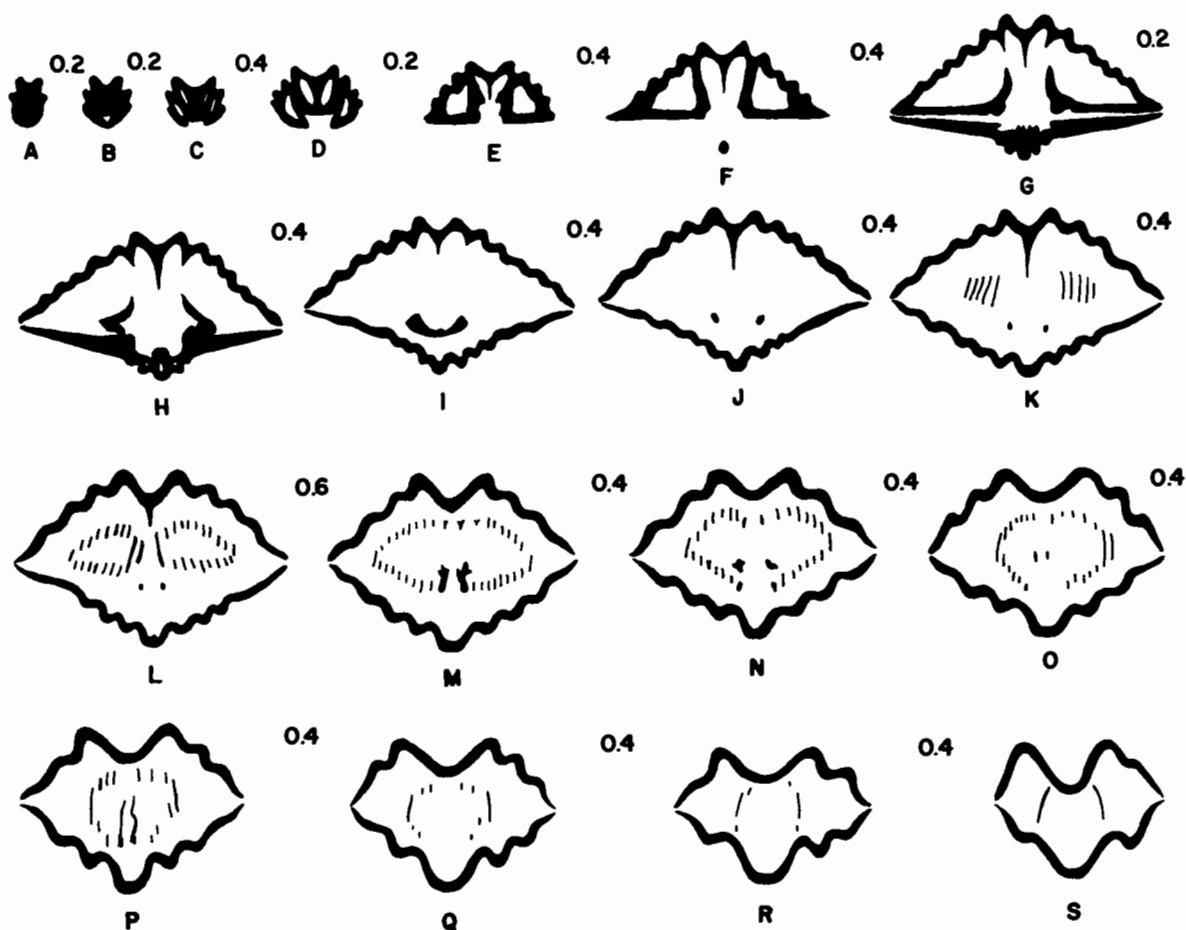


FIGURE 12.—Serial sections of *Punctospirifer kentuckyensis* var. *amesi* n. var. from locality Go-1; X3. Total length of specimen, 8.2 mm. Numbers indicate distance, in mm, between sections.

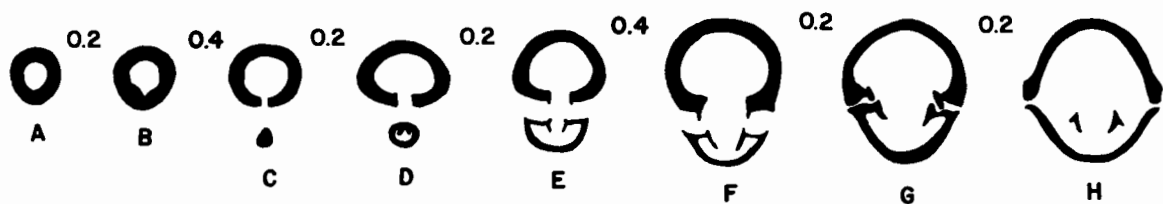


FIGURE 13.—Serial sections of *Phricodothyris perplexa* (McChesney) from locality Vc-6; X3. Spiralium missing. Total length of specimen, 9.7 mm. Numbers indicate distance, in mm, between sections.

317, pl. 42, figs. 5-8.

Phricodothyris perplexa? Hoare & Burgess, 1960, p. 714.

Condathyrus perplexa Hoare, 1961, p. 82-84, pl. 11, figs. 4-6.

Phricodothyris perplexa Pitrat (in Moore, 1965), p. 724, figs. 588, 2b-d.

Shell small to medium, with greatest width anterior to hinge line and maximum thickness posterior to mid-length. Brachial valve with small beak, tightly incurved over hinge line; umbo moderately inflated; surface evenly convex; hinge line less than half width of shell; posterolateral regions sharply rounded; and a low, broad fold present anteriorly in some specimens. Pedicle valve with high, strongly arched umbonal region; beak small, overhanging cardinal area; delthyrium triangular, occupying nearly one-half of cardinal area; deltidial plates narrow and rising as flanges above area; surface evenly and more strongly convex than in brachial valve; and with a low, broad sulcus in many cases. Valve surfaces marked by concentric bands bearing rows of double-barreled spines of two distinct sizes. Bands also ornamented by very fine concentric lines of growth.

Brachial interior with a pair of lamellae extending from the lateral margins of the beak into the umbonal region, supporting the crural plates; dental sockets small and narrow; and muscle scars not impressed. Pedicle valve with small, elongate teeth, projecting from under edge of deltidial plates and not supported by lamellae, and slightly impressed muscle scars (fig. 13).

Measurements of four specimens from the Washingtonville shale at locality CSv-3 give the following average dimensions: length, 16.4 mm, width, 19.0 mm, and thickness, 11.4 mm.

Discussion.—*Phricodothyris perplexa* occurs rather commonly in the Pottsville and Allegheny units in Ohio. It is the only species of this genus recognized in the Pennsylvanian of North America, except for *P. transversa* (Mather) from the Morrowan of Arkansas. This latter species is distinguished by its more transverse shape and large size. A few of the Pottsville specimens in our collections, most of which are compressed, approached the dimensions and shape of *P. transversa* but appear more closely related to *P. perplexa*. Comparison of the forms from the Upper Allegheny with those lower in the section show some divergence in size, with the specimens higher in the section more commonly reaching a larger size. Very little difference in relative dimensions is present, and there being no other basis for separating them, they are all considered to belong to the same species. The occurrence of a fold and sulcus generally depends upon size, these features not normally being present in the smaller specimens.

Occurrence.—Rare in the Lower Mercer, Upper Mercer, and Ames units and rare to abundant in the Putnam Hill, Vanport, Zaleski, Columbiana, and Washingtonville units. Also reported from the Boggs unit by Morningstar (1922) and from the Cambridge unit by Mark (1912).

Repository.—Hypotypes, OSU-27119, 27120.

Genus *Beecheria* Hall & Clarke, 1893

Beecheria bovidens (Morton)

Pl. 22, figs. 15-19

Terebratula bovidens Morton, 1836, p. 150, pl. 2, fig. 4; Meek, 1872, p. 187, pl. 1, fig. 7; pl. 2, fig. 4.

Dielasma bovidens? Morningstar, 1922, p. 185.

Dielasma bovidens Dunbar & Condra, 1932, p. 304-

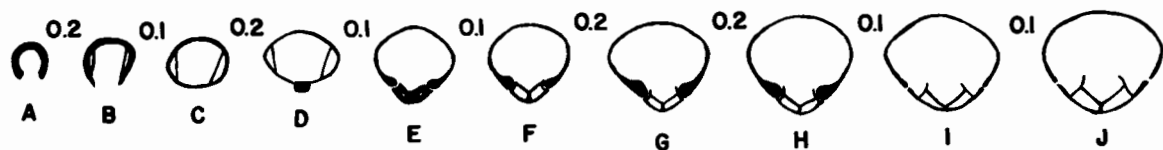


FIGURE 14.—Serial sections of *Beecheria bovidens* (Morton) from locality Vc-6; X5. Total length of specimen, 5.3 mm. Numbers indicate distance, in mm, between sections.

306, pl. 37, figs. 33, 34.

Beecheria bovidens Stehli, 1956, pl. 40, figs. A, 1-3;

Hoare, 1961, p. 33, 34, pl. 1, figs. 25, 26.

Shell small, elongate-oval in form, with maximum width at or anterior to mid-length, and greatest thickness posterior to mid-length. Brachial valve evenly convex; beak small; surface nearly flat to slightly convex longitudinally; and no fold. Pedicle valve with beak incurved over and covering brachial beak; foramen large, encroaching upon umbonal area; and faint sulcus beginning just posterior to umbonal region, becoming broader but remaining shallow anteriorly, forming slightly sinuate anterior margin. Shell finely punctate and marked by concentric growth lines.

Brachial interior with imperforate cardinal plate, medianly sessile, becoming divided into two plates extending laterally to join crural plates; primary lamellae springing from ends of crural plates; and dental sockets elongate, tapering. Pedicle interior with strongly developed dental plates.

Measurements of six specimens from the Putnam Hill and Vanport units give the following average dimensions: length, 8.1 mm, width, 7.0 mm, and thickness, 4.4 mm.

Discussion.—The specimens described above appear to be immature individuals of *Beecheria bovidens*. Although a sulcus is present it is not as pronounced as in specimens of this species illustrated by other authors. A comparison with *B. subspatulatum* (Weller) shows a relatively thinner shell and more pronounced appearance of the sulcus in *B. bovidens* at the same growth sizes. *B. bilobatum* (Mather) has a much stronger convexity than *B. bovidens*, and has a deep angular sulcus. Serial sections of a specimen showing the characteristic internal features are illustrated in figure 14.

Occurrence.—Rare in the Upper Mercer, Putnam Hill, and Brush Creek units; and rare to abundant in the Vanport unit. Also reported from the Lower Mercer unit by Morningstar (1922).

Repository.—Hypotypes, OSU-27121 to 27123.

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APPENDIX COLLECTING LOCALITIES

Specimens providing the basis for this report came from 22 stratigraphic units at 346 localities listed below in Athens, Carroll, Columbiana, Coshocton, Guernsey, Hocking, Holmes, Jackson, Jefferson, Lawrence, Licking, Mahoning, Morgan, Muskingum, Noble, Perry, Portage, Scioto, Stark, Summit, Tuscarawas, Vinton, and Wayne Counties (fig. 1). The localities are listed in numerical order under the respective counties and civil townships, where the order is alphabetical according to the county and township names. The capitalized first letter(s) of the locality number indicates the county, the small letter(s) the civil township, and the number following is our file number for that particular locality in the township. Exposures are located by sections or fractions thereof, by reference to various natural or cultural features, and/or by reference to elevation numbers on the pertinent 1:25,000 topographic maps, which are indicated in capital letters. This information is followed by the name of the stratigraphic unit(s) and, in parentheses, the number of collections made at the described locality; the file numbers of stratigraphic sections at or near the locality and available in the files of the Ohio Division of Geological Survey; and the names of identified genera and species, with abundance indicated: A, abundant, 15 or more; C, common, 5-14; R, rare, 4 or less. It should be noted that almost all of the deep and strip mines are no longer active.

ATHENS COUNTY:

Alexander Township¹:

- Aal-1. Exposure east and southeast of road junction at elev. no. 808, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 35, THE PLAINS. Ames (1). OGS 11246. *Rhipidomella carbonaria* (R), *Neochonetes semiacanthus* (A), *Juresania nebrascensis* (C), *Linoproductus* sp. (R), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (A), *Punctospirifer kentuckyensis amesi* (R).
- Aal-2. Exposure south along creek and road, beginning at bend of road, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 36, THE PLAINS. Ames (1). OGS 11247. *Linoproductus prattenianus* (R).
- Aal-4. Exposure on east side of road (formerly Rte. 50) on small hill, approx. 0.5 mi. (airline) northeast of Fisher and 0.15 mi. southwest of Snowden Cem. on east side of Margaret Cr., THE PLAINS. Portersville (1). OGS 11482. *Chonetinella alata* (A), *Neospirifer*

latus (A).

- Aal-6. Exposure in ravine, east side of Margaret Cr., southeast of BM 665, THE PLAINS. Ames and Portersville (1). OGS 11435. *Chonetinella alata* (C), *Neochonetes semiacanthus* (C), *Antiquatonia portlockiana* (R), *Neospirifer dunbari* (C).
- Aal-7. Exposure in first ravine north of elev. no. 684, east side of Margaret Cr., approx. 0.85 mi. east-northeast of Hebardville, THE PLAINS. Ames and Portersville (1). OGS 11249. *Chonetinella alata* (A), *Neochonetes semiacanthus* (R).
- Aal-8. Exposure along ravine, east side of Margaret Cr., SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, ALBANY. Ames (1). OGS 11250. *Crurithyris planoconvexa* (C).
- Aal-9. Exposure along road southwest from creek, E $\frac{1}{2}$ NE $\frac{1}{4}$ sec. 22, THE PLAINS. Ames (1). OGS 11436. *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (R).
- Aal-10. Exposure along ravine and road to abandoned Buck's Speedway, south of Ervin Run, approx. 0.6 mi. east of BM 664 and 0.75 mi. east-southeast of Fisher, THE PLAINS. Portersville (1). OGS 11625. *Chonetinella alata* (A), *C. flemingi* (R), *Crurithyris planoconvexa* (A).
- Aal-11. Exposure in ravine, south of Rte. 50, directly south-southwest of road junction at elev. no. 677 and 0.2 mi. east of Snowden Cem., THE PLAINS. Portersville (5). OGS 11626. *Chonetinella alata* (A), *Neochonetes granulifer* (R), *Neospirifer latus?* (C).
- Aal-12. Exposure along east side of road at pasture gate at road junction at elev. no. 710, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, ATHENS. Ames (1). OGS 11251. *Neochonetes semiacanthus* (R), *Crurithyris planoconvexa* (A).
- Aal-16. Exposure along road southwest from road junction at elev. no. 701, approx. 0.6 mi. south of road junction at elev. no. 729, at Clearview on Rte. 50, ATHENS. Ames (1). OGS 11440. *Neochonetes semiacanthus* (R).
- Aal-41. Exposure in cut along Rte. 50, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 29, THE PLAINS. Ames (1). OGS 11435. *Juresania nebrascensis* (R), *Antiquatonia portlockiana* (R), *Linoproductus prattenianus* (R), *L. cf. L. platyumbonus* (R), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (R).

Ames Township:

- Aam-5. Exposure along Mush Run, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, STEWART. Skelley (1). OGS 8970. *Derbyia* sp. (R), *Juresania nebrascensis* (A), *Antiquatonia portlockiana?* (R), *Linoproductus cf. L. platyumbonus* (R), *Neospirifer dunbari* (R), *Composita* sp. (R).
- Aam-7. Exposure along ravine south of farm buildings, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, JACKSONVILLE. Ames and Skelley (3). OGS 8972. *Neochone-*

1. Alexander and Athens Townships are not divided into sections but in some cases it is desirable to indicate what the section would be to facilitate designation of locations.

- tes semiacanthus* (C), *Hystriculina wabashensis* (C), *Juresania nebrascensis* (A), *Lino-productus* cf. *L. platyumbonus* (R), *Composita magna* (A), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (A).
- Aam-19. Exposure (type locality for Ames) uphill along road between Bryson Br. road junction at elev. no. 824, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 21, JACKSONVILLE. Ames (1). OGS 8984. *Echinaria moorei* (R), *Juresania nebrascensis* (R), *Antiquatonia portlockiana* (C), *Lino-productus prattenianus* (R), *Crurithyris planoconvexa* (C), *Neospirifer dunbari* (R).
- Aam-20. Exposure along Rte. 50A and farm lane at road junction at elev. no. 667 and in adjacent pasture, NE $\frac{1}{4}$ sec. 20, JACKSONVILLE. Gaysport (1). OGS 8985. *Lino-productus* cf. *L. platyumbonus* (R), *Composita magna* (R), *Crurithyris planoconvexa* (A), *Neospirifer latus* (R).
- Aam-27. Exposure along Rte. 280 and uphill toward old house, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 11, AMESVILLE. Ames (1). OGS 8992. *Crurithyris planoconvexa* (A).
- Aam-41. Exposures along Rte. 50A and stream in SW $\frac{1}{4}$ sec. 27 and SE $\frac{1}{4}$ sec. 33, JACKSONVILLE. Ames (2). OGS 8977. *Derbyia parvicostata*? (R), *Neochonetes* sp. (R), *Echinaria moorei* (R), *Juresania nebrascensis* (C), *Antiquatonia* sp. (C), *Lino-productus prattenianus* (R), *L. sp.* (R), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (A).
- Aam-42. Exposure on A. A. Kasler farm, east side Bryson Br., approx. 0.5 mi. north of junction of Bryson and McDougall Brs., JACKSONVILLE. Ames (1). *Neochonetes semiacanthus* (R), *Crurithyris planoconvexa*? (C).
- Athens Township¹:
- Aa-1. Exposure near hilltop, northeast side Rte. 13 (formerly Rte. 33), approx. 0.1 mi. northwest of junction of Rtes. 13 and 33 at elev. no. 659, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 18, ATHENS. Ames, Lower and Upper Brush Creek (2). OGS 11484. *Derbyia* sp. (R), *Kozlowskia splendens* (A), *Echinaria* sp. (R), *Juresania nebrascensis* (C), *Antiquatonia portlockiana*? (R), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (C), *N. sp.* (R).
- Aa-2. Exposure along Radford Rd. between road junctions at elev. nos. 651 and 745, approx. 0.4 mi. south of West Branch Margaret Cr., THE PLAINS. Portersville (1). OGS 11223. *Chonetinella alata* (A).
- Aa-3. Exposure along Rte. 50 southwest of junction of Rtes. 33 and 50 below level of Gateway Motor Lodge, ATHENS. Ames (1). OGS 11627. *Derbyia* sp. (C), *Neochonetes semiacanthus* (A), *Juresania* sp. (R), *Antiquatonia portlockiana* (R), *Lino-productus* cf. *L. platyumbonus* (R), *L. sp.* (R), *Crurithyris planoconvexa* (A), *Punctospirifer kentuckyensis amesi* (R), *Neospirifer dunbari* (C).
- Aa-4. Exposure along Vore Ridge Rd., northwest of Vore Ridge Church, THE PLAINS. Ames (1). OGS 11628. *Chonetinella alata* (R).
- Aa-6. Exposure in tributary ravine to Factory Cr., north of Brookville and south-southwest of hill with elev. no. 926, THE PLAINS. Ames and Portersville (1). OGS 11629. *Chonetinella alata* (C).
- Aa-7. Exposure along northeast flowing tributary to Factory Cr., approx. 0.6 mi. southeast of Brookville, THE PLAINS. Portersville (1). OGS 11631. *Chonetinella alata* (C).
- Aa-10. Exposure along tributary ravine, northeast side of Ross Hollow, due north of junction of Ross Run and West Branch Margaret Cr. and northwest of hill with elev. no. 835, THE PLAINS. Ames (1). OGS 11634. *Neochonetes semiacanthus* (R), *Juresania nebrascensis* (R), *Crurithyris planoconvexa* (C), *Neospirifer* sp. (R).
- Aa-12. Exposure on east side of Rtes. 33 and 50A, north of Athens and almost due east of Armitage, ATHENS. Portersville (2). OGS 11434. *Chonetinella alata* (A), *Neospirifer dunbari* (A).
- Aa-13. Exposure along road southwest of road junction at elev. no. 742, approx. 0.45 mi. west-northwest of center of The Plains, THE PLAINS. Portersville (1). OGS 11485. *Chonetinella alata* (A).
- Aa-14. Exposure in ravine north of road, approx. 1.1 mi. west-southwest of road junction at elev. no. 742, west-northwest of The Plains, THE PLAINS. Ames (1). OGS 11226. *Juresania nebrascensis* (C), *Antiquatonia portlockiana* (C), *Lino-productus* cf. *L. platyumbonus* (R), *L. oklahomae* (R), *L. sp.* (R), *Neospirifer dunbari* (C).
- Aa-15. Exposure along northwest side Rte. 50A, approx. 0.5 mi. south of Athens-Dover Tp. line, NW $\frac{1}{4}$ sec. 12, ATHENS. Upper Brush Creek (1). OGS 11227. *Juresania nebrascensis pulchra* (R).
- Aa-23. Exposures in two ravines, south side of Hocking R. between two elongate ponds approx. 0.8 mi. northwest of Armitage, ATHENS. Gaysport (1). OGS 11231. *Neochonetes semiacanthus*? (R).
- Aa-27. Exposure in ravine on south side of Hocking R., Athens State Hospital grounds, ATHENS. Ames (2). OGS 11235. *Derbyia* sp. (R), *Neochonetes semiacanthus* (R), *Hystriculina wabashensis* (R), *Crurithyris planoconvexa* (C), *Neospirifer dunbari* (A), *Punctospirifer kentuckyensis amesi* (R).
- Aa-36. Exposure uphill along Mulligan Rd. beginning approx. 100 yds. east of Richland Ave. in south part of Athens, ATHENS. Ames (1). OGS 11243. *Crurithyris planoconvexa* (A).
- Aa-38. Exposure along Rock Riffle Run near its mouth on east side of Hocking R. directly east of Ohio Univ. in vicinity of road junction at elev. no. 639, ATHENS. Cambridge (1). OGS 11245. *Chonetinella plebeia*? (R), *Antiquatonia* sp. (R).
- Aa-41. Exposure at cliff, east side of Rte. 56, 0.4 mi. south of junction of Rtes. 56 and 682, THE PLAINS. Lower Brush Creek (numerous). OGS 12158. *Orbiculoidea missouriensis* (R), *Derbyia* sp. (R), *Chonetinella plebeia* (A), *Kozlowskia splendens* (A), *Juresania nebrascensis* (A), *Antiquatonia portlockiana* (A), *Lino-productus prattenianus* (A), *L. cf.*

- L. platyumbonus* (R), *Cancrinella boonensis* (R), *Composita ovata* (A), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (A).
- Aa-46. Exposure at uncertain locality, west of Rtes. 33 and 50 and 0.75 to 1.75 mi. south of Hocking R., ATHENS. Portersville (1). *Chonetinella alata* (C).
- Aa-47. Exposure on east side of Hastings Rd. between Hooper St. and Rock Riffle Run, ATHENS. Ames (1). *Neochonetes semiacanthus* (R), *Antiquatonia portlockiana* (R), *Crurithyris planoconvexa* (R), *Neospirifer dunbari* (R).
- Aa-48. Undescribed and uncertain exposure, north-northeast edge of Athens, ATHENS. Ames (1). *Neochonetes semiacanthus* (R), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (R).
- Aa-49. Undescribed exposure southwest of Athens State Hospital buildings (probably along valley of Dairy Run), ATHENS. Ames (1). *Neochonetes semiacanthus* (A), *Juresania nebrascensis* (A), *Antiquatonia portlockiana* (A), *Linoproductus* cf. *L. platyumbonus*? (R), *Cancrinella boonensis* (R), *Crurithyris planoconvexa* (A).
- Aa-50. Exposures along roads in Emerson Ball real estate development along valley northwest of Rte. 50 and west-northwest of Clearview, ATHENS. Ames (1). *Derbyia crassa* (R), *Chonetinella alata* (R), *Neochonetes semiacanthus* (R), *Hystriculina wabashensis* (R), *Juresania nebrascensis* (C), *Antiquatonia portlockiana* (R), *Linoproductus prattenianus* (C), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (A).
- Aa-51. Exposure (now concealed) in basement excavation for Bromley Hall, northwest corner Congress and Union Sts., Athens, ATHENS. Portersville (1). See OGS 11237. *Neospirifer latus* (R).
- Aa-52. Exposure at foot of stairs, north side of Fort St., Athens, ATHENS. Ames (1). OGS 13399. *Neospirifer dunbari*? (R).
- Canaan Township:**
- Acn-4. Exposure in ravine, north side Rte. 50, NW $\frac{1}{4}$ sec. 34 and SW $\frac{1}{4}$ sec. 35, ATHENS. Portersville (1). OGS 11285. *Chonetinella alata* (R), *C. verneuliana* var. (R), *Neospirifer dunbari* (C).
- Acn-19. Exposure on north side of Strouds Run and Park Roads, south-southwest of Strouds Run Church, north side of Dow Lake, N $\frac{1}{2}$ sec. 29, ATHENS. Ames (1). OGS 11639. *Neochonetes semiacanthus* (R), *Crurithyris planoconvexa* (A).
- Dover Township:**
- Ad-4. Exposures in small ravines, west of north-south road, ctr. and NW $\frac{1}{4}$ sec. 35, NELSONVILLE. Portersville (4). OGS 6718. *Chonetinella alata* (A), *Neospirifer* sp. (R).
- Ad-10. Exposure along ravine west of road junction at elev. no. 994 (Liars Corners), NW $\frac{1}{4}$ sec. 14, JACKSONVILLE. Cambridge (1). OGS 6724. *Composita* sp. (R), *Neospirifer* sp. (R), *Juresania nebrascensis pulchra* (R).
- Ad-12. Exposures in mine entrances and strip mine and along Rte. 675 and Utah Ridge Rd., ctr. and NW $\frac{1}{4}$ sec. 36, NELSONVILLE. Ames and Portersville (1). OGS 11594. *Neospirifer dunbari* (R).
- Ad-13. Composite exposure, north side of tributary valley to Bailey Run, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 35, NELSONVILLE. Ames (1). OGS 11493. *Neospirifer dunbari* (R), *Punctospirifer kentuckyensis amesi* (R).
- Ad-19. Exposure in ravine, south side of Hocking R., NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25 and NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 31, NELSONVILLE. Cambridge (1). OGS 11460. *Composita elongata*? (R).
- Ad-20. Exposure along east-west road, east of road junction at elev. no. 722, N $\frac{1}{2}$ SW $\frac{1}{4}$ sec. 12, JACKSONVILLE. Undifferentiated Brush Creek (1). OGS 11573. *Chonetinella plebeia* (R), *Cancrinella boonensis* (R).
- Ad-23. Exposure north of east-west road and east of ravine, northeast of road junction at elev. no. 682, East Millfield, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 11, JACKSONVILLE. Ames (1). OGS 11298. *Derbyia parvicostata*? (R), *Neochonetes semiacanthus*? (R), *Juresania nebrascensis* (R), *J. n. pulchra* (R), *Crurithyris planoconvexa* (A), *Neospirifer* sp. (R), *Punctospirifer kentuckyensis amesi* (R).
- Ad-30. Exposure in ravine opposite Hilltop Cem., Millfield, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16, JACKSONVILLE. Lower Brush Creek (1). OGS 11304. *Chonetinella plebeia* (A), *Juresania nebrascensis* (R).
- Ad-32. Exposures along valley and tributary valley, NW $\frac{1}{4}$ and NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 15, JACKSONVILLE. Lower and Upper Brush Creek (1). OGS 11462. *Lingula carbonaria* (R), *Pulchratia symmetrica regularis*? (R), *Juresania nebrascensis* (R), *J. n. pulchra* (A), *Antiquatonia portlockiana* (C), *Linoproductus prattenianus* (C), *Composita ovata*? (R).
- Ad-35. Exposure (now graded over) on west side Rte. 50A, west and northwest of Poston M.E. Church NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 7, JACKSONVILLE. Portersville (1). OGS 11308. *Chonetinella alata* (A), *Neospirifer latus* (C).
- Ad-36. Exposure at Henry Augustine farm buildings, northwest side Rte. 50A, S $\frac{1}{2}$ SW $\frac{1}{4}$ sec. 7 (Dover Tp.) and N $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 12 (Athens Tp.), ATHENS. Ames (1). OGS 11309. *Neospirifer dunbari*? (R).
- Ad-37. Exposure along east side Rte. 50A just south of road junction at elev. no. 710, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 2, JACKSONVILLE. Cambridge (2). OGS 11310. *Pulchratia symmetrica regularis* (R), *Composita ohioense* (C).
- Ad-42. Exposure along creek on Joe Chiki farm, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 1, ATHENS. Portersville (1). OGS 11313. *Chonetinella alata* (A), *Crurithyris planoconvexa* (A).
- Ad-46. Undescribed exposure (possibly along north-south road) W ctr. sec. 7, JACKSONVILLE. Ames (1). *Neochonetes semiacanthus* (C), *Juresania nebrascensis* (R), *Antiquatonia portlockiana* (C), *Linoproductus* sp. (R).
- Ad-47. Exposure along lane, N $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 4, JACKSONVILLE. Ames (1). *Neochonetes semiacanthus* (R), *Neospirifer dunbari* (R).

- Ad-48. Undescribed and uncertain exposure, SW $\frac{1}{4}$ /SW $\frac{1}{4}$ sec. 28, NELSONVILLE. Undifferentiated Brush Creek (1). See OGS 11454. *Composita ovata*? (R).

Lee Township:

- Ale-1. Exposure along ravine, NE $\frac{1}{4}$ sec. 6, THE PLAINS. Lower and Upper Brush Creek (1). OGS 11542. *Juresania nebrascensis pulchra* (R).
- Ale-4. Exposure along creek and road, SE $\frac{1}{4}$ /SE $\frac{1}{4}$ sec. 5, THE PLAINS. Undifferentiated Brush Creek (2). OGS 11545. *Lingula carbonaria* (R), *Chonetinella plebeia* (C), *Linoproductus prattenianus*? (R), *Neospirifer dunbari* (R).
- Ale-12. Exposures in two ravines on north side of tributary to Onion Cr., SW $\frac{1}{4}$ sec. 23, MINERAL. Upper Brush Creek (1). OGS 11552. *Antiquatonia portlockiana crassicosata*? (R), A. sp. (R).
- Ale-18. Diamond Stone Quarries, Inc., Plant No. 2 (formerly Shamrock Quarries, Inc., and earlier Dickson Bros. Quarry), north side Rte. 50, NW $\frac{1}{4}$ sec. 13, and SW $\frac{1}{4}$ sec. 14, ALBANY. Lower and Upper Brush Creek (3). OGS 11559. *Chonetinella plebeia* (C), *Kozlowskia splendens* (R), *Pulchratia symmetrica regularis* (C), *Juresania nebrascensis*? (R), *J. n. pulchra* (A), *Antiquatonia portlockiana* (A), A. p. *crassicosata* (A), *Linoproductus prattenianus* (R), L. cf. *L. platyumbonus* (R), *Canocrinella boonensis* (C), *Composita ovata* (A), *Neospirifer latus* (A).
- Ale-19. Diamond Stone Quarries, Inc., Plant No. 1 (formerly Stinson Quarry), east of Columbia Rd. and south of Rte. 50 and along Leading Cr., N $\frac{1}{2}$ /NE $\frac{1}{4}$ sec. 7, ALBANY. Lower and Upper Brush Creek (2). OGS 11560. *Chonetinella plebeia* (C), *Pulchratia symmetrica regularis* (R), *Juresania nebrascensis pulchra* (A), *Antiquatonia portlockiana crassicosata*? (A), *Linoproductus prattenianus* (A), L. cf. *L. platyumbonus*? (R), *Canocrinella boonensis* (R), C. sp. (R), *Composita subtilita* (C), C. *ovata* (A), C. *ohioense* (R), *Neospirifer dunbari* (A).
- Ale-28. Abandoned quarry, NE $\frac{1}{4}$ /NE $\frac{1}{4}$ sec. 15, ALBANY. Undifferentiated Brush Creek (2). OGS 11569. *Orbiculoidea missouriensis*? (R), *Chonetinella plebeia* (A), *Juresania nebrascensis*? (R), *Antiquatonia portlockiana* (A), *Linoproductus prattenianus* (C), *Neospirifer latus* (C).
- Ale-33. Abandoned quarry, NE $\frac{1}{4}$ /NE $\frac{1}{4}$ sec. 13, ALBANY. Undifferentiated Brush Creek (1). *Orbiculoidea capuliformis* (R), *Chonetinella plebeia* (R), *Pulchratia symmetrica regularis* (R), *Juresania nebrascensis pulchra* (A), *Antiquatonia portlockiana* (A), *Linoproductus prattenianus* (C), L. sp. (R), *Canocrinella boonensis* (R).

Trimble Township:

- At-1. Exposure along diagonal road, NE $\frac{1}{4}$ /NE $\frac{1}{4}$ sec. 6, CORNING. Ames (1). OGS 11647. *Neospirifer* sp. (R).
- At-4. Exposure in abandoned NYC RR. cut (originally tunnel), northwest of Bishopville,

NE $\frac{1}{4}$ /NE $\frac{1}{4}$ sec. 4, CORNING. Portersville (4). OGS 6676. *Derbyia crassa* (C), *Chonetinella alata* (A), *Chonetinella flemingi* (R), C. *verneuliana* var. (R), *Antiquatonia portlockiana* (R), *Crurithyris planoconvexa* (A), *Neospirifer latus* (A).

- At-9. Exposure along southwest side of Rte. 13, 0.8 mi. north of Glouster, SE $\frac{1}{4}$ /NE $\frac{1}{4}$ sec. 10, CORNING. Lower Brush Creek (3). OGS 6680. *Chonetinella plebeia* (A), *Juresania nebrascensis* (R), J. n. *pulchra* (R).
- At-37. Exposure in pit of abandoned Wassall Brick Co., Glouster, SW $\frac{1}{4}$ /NE $\frac{1}{4}$ sec. 9, JACKSONVILLE. Undifferentiated Brush Creek (1). OGS 5193. *Composita ovata*? (R).
- At-45. Exposure in pit of abandoned Trimble Brick Mfg. Co., north side of Rte. 280, east of Trimble, N $\frac{1}{2}$ /SW $\frac{1}{4}$ sec. 2, JACKSONVILLE. Portersville (1). OGS 6698. *Chonetinella alata* (C), *Antiquatonia portlockiana* (R), *Crurithyris planoconvexa* (R), *Neospirifer latus*? (R).
- At-59. Exposure in prospect pit along road, SW $\frac{1}{4}$ /NW $\frac{1}{4}$ sec. 27, NEW STRAITSVILLE. Portersville (2). OGS 6712. *Derbyia crassa* (R), *Chonetinella alata* (A), C. *flemingi* (R), C. sp. (R), *Neospirifer latus* (C).
- At-64. Exposure along east-west stream and at abandoned drift mine, S $\frac{1}{2}$ sec. 1, JACKSONVILLE. Portersville (1). OGS 11648. *Lingula carbonaria* (R), *Chonetinella alata* (A), *Neospirifer latus* (A), *Composita ovata* (R).
- At-66. Float material along road, NE $\frac{1}{4}$ /NE $\frac{1}{4}$ sec. 13, JACKSONVILLE. Portersville (1). *Chonetinella alata* (C).

Waterloo Township:

- Aw-11. Exposure along Marshfield-Mineral Rd., east of junction with Rte. 356, approx. 0.5 mi. south of Mineral, S $\frac{1}{2}$ /NE $\frac{1}{4}$ sec. 26, MINERAL. Lower Brush Creek (2). OGS 7580. *Chonetinella plebeia* (A), *Antiquatonia portlockiana* (R), *Canocrinella boonensis* (R).
- Aw-37. Exposures along road northwest from road junction at elev. no. 698, W ctr. sec. 4, toward road junction at elev. no. 911 in E ctr. sec. 16, THE PLAINS. Lower Brush Creek (1). OGS 7607. *Linoproductus* sp. (R), *Neospirifer dunbari* (C).
- Aw-40. Exposures along road west-southwest of road junction at elev. no. 737, sec. 11, THE PLAINS. Undifferentiated Brush Creek (1). OGS 7610. *Chonetinella plebeia* (A).
- Aw-45. Exposure on west side of north-south ravine, north of Vore Ridge Rd., approx. 0.4 mi. east of road junction at elev. no. 730, SE $\frac{1}{4}$ /SW $\frac{1}{4}$ sec. 5, THE PLAINS. Undifferentiated Brush Creek (1). OGS 7615. *Chonetinella plebeia* (A), *Juresania* sp. (R).
- Aw-47. Exposure in B & O RR. cut at northeast edge of New Marshfield, NW $\frac{1}{4}$ /SW $\frac{1}{4}$ sec. 9, THE PLAINS. Lower Brush Creek (1). OGS 7617. *Chonetinella plebeia* (C).
- Aw-48. Exposure along ravine, N $\frac{1}{2}$ /SW $\frac{1}{4}$ sec. 3, THE PLAINS. Upper Brush Creek and Portersville (5). OGS 7618. *Chonetinella plebeia* (A), C. *alata* (A), C. *flemingi* (R), C. *verneuliana* var. (R), *Juresania nebrascensis* (R), *Antiquatonia* sp. (R).

quatonina portlockiana (C), *Linoproductus prattenianus* (C), *L. sp.* (R), *Neospirifer latus* (A).

- Aw-49. Exposure along road, west of road junction at elev. no. 699, ctr. sec. 2, THE PLAINS. Lower Brush Creek (1). OGS 7619. *Chonetinella plebeia* (R), *Desmoinesia sp.* (R), *Juresania sp.* (R), *Linoproductus sp.* (C), *Composita sp.* (R), *Neospirifer dunbari*? (R).
- Aw-51. Exposures in ravines, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, and NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 7, THE PLAINS. Lower and Upper(?) Brush Creek (1). OGS 7621. *Derbyia parvicostata*? (R), *Chonetinella plebeia* (A), *Linoproductus prattenianus* (A), *Composita subtilita* (R), *C. ovata* (R), *Neospirifer dunbari* (C).
- Aw-54. Exposure, S $\frac{1}{2}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 18, THE PLAINS. Portersville (1). *Chonetinella alata* (R).

York Township:

- Ay-9. Exposure along Mud Sock Rd. just north of road junction at elev. no. 783 on north side of Minkers Run, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, NELSONVILLE. Dorr Run (1). OGS 11576. *Lingula carbonaria* (R), *Orbiculoidea missouriensis*? (A).
- Ay-11. Exposure along Mud Sock Rd. on south side of Hocking Valley, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, NELSONVILLE. Dorr Run (1). OGS 6733. *Lingula carbonaria* (A).
- Ay-21. Exposure along road just west of road junction at elev. no. 924, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 4, NELSONVILLE. Cambridge (2). OGS 6743. *Orbiculoidea capuliformis*? (R), *Derbyia sp.* (R), *Pulchratia symmetrica regularis* (R), *Juresania nebrascensis pulchra* (R), *J. sp.* (C), *Linoproductus sp.* (R), *Composita ohioense* (A).
- Ay-26. Abandoned strip mine in ravine, north side of Rte. 33 and east side of Coe Hollow Rd., SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 11, NELSONVILLE. Dorr Run (1). OGS 6748. *Lingula carbonaria* (A), *Pulchratia symmetrica regularis* (C).
- Ay-37. Exposures in abandoned strip mines and along tributary to Hewett Fk., NW $\frac{1}{4}$ sec. 32, UNION FURNACE. Dorr Run (1). OGS 11479. *Lingula carbonaria* (R).
- Ay-38. Exposures in deep and strip mines and along road to southeast, SW $\frac{1}{4}$ sec. 26, UNION FURNACE. Dorr Run (1). OGS 11480. *Lingula carbonaria* (C).
- Ay-56. Exposure along northeast side Rte. 33, approx. 0.225 mi. east of Athens-Hocking County line, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, UNION FURNACE. Putnam Hill (1). OGS 14301. *Juresania sp.* (R).
- Ay-61. Undescribed exposure, probably near elev. no. 1072, ctr. sec. 35, UNION FURNACE. Ames(?) (1). ?*Fimbriaria sp.* (R), *Juresania nebrascensis* (A), *Antiquatonia portlockiana* (C), *Linoproductus cf. L. platyumbonus*? (C), *L. sp.* (R), *Neospirifer dunbari* (A).
- Ay-62. Exposure in abandoned strip mine east of Poston School and Rte. 691, approx. 1.0 mi. southwest of Kimberly, NELSONVILLE. Dorr Run (1). *Lingula carbonaria* (A).

Uncertain localities:

- Auc-1. Undescribed exposure at unknown locality

(possibly Lee Tp.). Portersville (1). *Chonetinella alata*?, *C. flemingi*?, *Linoproductus cf. L. magnispinus*? (R).

- Auc-2. Undescribed exposure at unknown locality. Portersville (1). *Chonetinella alata* (A), *Neospirifer latus* (C).

CARROLL COUNTY:

Center Township:

- CAC-1. Abandoned quarry (formerly operated by the Hanna Coal Co.), N $\frac{1}{2}$ sec. 13, CARROLLTON. Ames (3). OGS 15560, 15570. *Neochonetes granulifer* (A), *Hystriculina wabashensis* (R), *Juresania nebrascensis* (C), *Antiquatonia portlockiana* (A), *Linoproductus sp.* (R), *Hustedia mormoni* (R), *Composita subtilita* (A), *Crurithyris planoconvexa* (R), *Neospirifer dunbari* (A), *Punctospirifer kentuckyensis amesi* (C).
- CAC-2. Abandoned quarry (formerly operated by the Hanna Coal Co. and later by Joe Skinner), ctr. and SE $\frac{1}{4}$ sec. 14, CARROLLTON. Ames (2). OGS 15462, 15569. *Crania modesta* (R), *Enteletes hemiplicatus*? (C), *Orthotetes conemaughensis* (R), *Derbyia crassa* (R), *Neochonetes granulifer* (A), *Leptalosia ovalis* (R), *Hystriculina wabashensis* (R), *Pulchratia cf. P. ovalis* (R), *Echinaria moorei* (C), *Juresania nebrascensis* (A), *Antiquatonia portlockiana* (A), *Reticulatia huecoensis* (A), *Linoproductus prattenianus* (A), *Hustedia mormoni* (R), *Composita subtilita* (A), *C. argentea* (A), *Neospirifer dunbari* (A), *Punctospirifer kentuckyensis amesi* (C).

Fox Township:

- CAf-1. Undescribed exposure, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 31, BERGHOLZ. Ames(?) (1). *Juresania nebrascensis* (R), *Linoproductus cf. L. platyumbonus* (R).

Lee Township:

- CA1-1. Quarries, north of Trail Run, SW $\frac{1}{4}$ and SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, BERGHOLZ. Ames (2). OGS 12518. *Derbyia parvicostata*? (R), *Neochonetes semiacanthus* (C), *N. granulifer* (R), *Juresania nebrascensis* (R), *Antiquatonia portlockiana*? (R), *A. sp.* (R), *Linoproductus prattenianus* (R), *L. sp.* (R), *Composita subtilita*? (C), *C. argentea* (R), *Crurithyris planoconvexa* (R), *Neospirifer dunbari*? (C), *Punctospirifer kentuckyensis amesi* (R).
- CA1-2. Abandoned quarry, northeast of Rtes. 9 and 43, NW $\frac{1}{4}$ sec. 17, CARROLLTON. Ames (1). OGS 12517. *Neochonetes granulifer* (C), *Antiquatonia portlockiana* (R), *Hustedia mormoni* (C), *Composita ovata* (A), *Crurithyris planoconvexa* (R), *Neospirifer dunbari*? (R).

Rose Township:

- CAR-1. Abandoned strip mine (now recreation area), northwest side Rte. 183 (formerly Rte. 80), just northwest of dairy farm buildings on south side of Rte. 183, W ctr. sec. 36, WAYNESBURG. Putnam Hill (3). OGS 12627. *Kozlowskia haydenensis*? (R), *Reticulatia rugatua*? (R), *Composita sp.* (R), *Neospirifer cameratus* (R).

COLUMBIANA COUNTY:

Center Township:

- Cc-3. Exposure along stream south of east-west road near ctr. sec. 15, LISBON. Washingtonville (1). OGS 1694. *Mesolobus mesolobus*? (R).
- Cc-4. Exposures in vicinity of Excelsior Clay Products Co. and along Rte. 164, E $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 23, LISBON. Washingtonville (2). OGS 5263. *Eolissochonetes fragilis* (R), *Mesolobus mesolobus* (C), *Desmoinesia muricatina* (A), *Antiquatonia* sp. (R), *Composita subtilita*? (C), *Neospirifer cameratus* (R).
- Cc-5. Exposure along lower part of ravine on west side Middle Fork Little Beaver Cr. west of Logtown, S $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 9, LISBON. Washingtonville (1). *Lingula carbonaria* (C).
- Cc-6. Abandoned Dunn & Kirk Mine along Middle Fork Little Beaver Cr., ctr. sec. 9, LISBON. Columbiana (1). *Derbyia* sp. (R).
- Cc-7. Exposure along tributary valley to Middle Fork Little Beaver Cr., SW $\frac{1}{4}$ sec. 9, LISBON. Washingtonville (1). *Derbyia* sp. (R).

Elk Run Township:

- Cer-3. Exposure along Middle Run, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 20, ELKTON. Vanport (1). OGS 1681. *Mesolobus obsoletus* (A).
- Cer-4. Abandoned strip mine, east of Rte. 30, E ctr. sec. 31. WEST POINT. Undifferentiated Brush Creek (1). *Chonetinella plebeia* (R), *Crurithyris planoconvexa* (A).

Hanover Township:

- Ch-1. Exposure along Pennsylvania RR., SW $\frac{1}{4}$ sec. 33, KENSINGTON. Undifferentiated Brush Creek (1). OGS 2094. *Lingula carbonaria* (C), *Orbiculoidea missouriensis*? (C).

Knox Township:

- Ck-1. Abandoned F. K. Fryogle shaft, W ctr. sec. 12, DAMASCUS. Columbiana (1). OGS 2150. *Reticulatia rugatia* (R).

Madison Township:

- Cma-4. Exposure on north side of Alderlick Rd. and east side of hill, E ctr. sec. 30, WEST POINT. Ames (1). *Hystriculina wabashensis* (R), *Neospirifer dunbari*? (R), *Punctospirifer kentuckyensis amesi* (R).

Perry Township:

- Cp-2. Abandoned Allison Mine, just southwest of junction of Egypt and Pine Lake Rds., N ctr. sec. 29, SALEM. Columbiana (1). OGS 3777. *Mesolobus lioderma* (A), *Composita* sp. (C).
- Cp-3. Abandoned Brookwood Mine (type locality for Columbiana), SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, SALEM. Columbiana (1). OGS 3778. *Lingula carbonaria* (R), *Derbyia crassa* (R), *Mesolobus lioderma* (A), *Desmoinesia muricatina* (R), *Juresania nebrascensis* (R), *Reticulatia rugatia* (C), *Composita* sp. (C), *Neospirifer goreii* (R), *Phricodothyris perplexa* (C).
- Cp-4. Exposure in ravine north of Pennsylvania RR., NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, DAMASCUS. Washingtonville (1). OGS 3765. *Desmoinesia muricatina* (C), *Phricodothyris perplexa* (R).

- Cp-5. Abandoned J. T. Reese & Sons Mine, west side of Egypt Rd., NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, SALEM. Columbiana (1). OGS 1721. *Lingula carbonaria* (R), *Orbiculoidea missouriensis* (R), *Mesolobus lioderma* (R), *Desmoinesia muricatina* (C), *Juresania nebrascensis* (R), *Composita ovata*? (R), *Phricodothyris perplexa* (C).

Salem Township:

- Cs-3. Abandoned Delmore Mine, Sterling Coal Co., east of Franklin Square and north of Rte. 344, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 14, LISBON. Columbiana (1). OGS 1707. *Lingula carbonaria* (C), *Orbiculoidea missouriensis* (R), *Derbyia* sp. (R), *Mesolobus lioderma* (A), *M. obsoletus* (A), *Desmoinesia muricatina* (R), *Juresania nebrascensis* (R), *Reticulatia rugatia* (R), *Composita* sp. (C), *Phricodothyris perplexa* (A).
- Cs-5. Abandoned J. Fox & Howell Bros. Mine, east side of Cherry Valley Run just east of abandoned Y & O RR. bridge, SE $\frac{1}{4}$ sec. 1, SALEM. Washingtonville (1). OGS 3784. ?*Eolissochonetes fragilis* (R).
- Cs-7. Abandoned mine (Bossart or Buzzard's Glory?), west side Middle Fork Little Beaver Cr., SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, SALEM. Columbiana (2). *Lingula carbonaria* (A), *Derbyia crassa*? (R), *Mesolobus lioderma* (A), *Phricodothyris perplexa* (C).
- Cs-8. Abandoned McKeefry Shaft, west side of Middle Fork Little Beaver Cr., N ctr. sec. 15, LISBON. Columbiana (1). OGS 1901? *Lingula carbonaria* (R), *Orbiculoidea missouriensis* (R), *Derbyia* sp. (R), *Desmoinesia muricatina* (R), *Juresania nebrascensis* (R), *Neospirifer cameratus*? (R), *Phricodothyris perplexa* (C).
- Cs-10. Abandoned Salem Mining Co. mine along abandoned Y & O RR., NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, SALEM. Columbiana (2). OGS 1717. *Phricodothyris perplexa* (C).
- Cs-11. Abandoned J. A. Sanders Mine, east side of Lisbon Rd., NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 3, SALEM. Columbiana (1). OGS 3786. *Lingula carbonaria* (A), *Orbiculoidea missouriensis*? (R), *Composita subtilita* (C).
- Cs-12. Abandoned Weikart Mine, west of Middle Fork Little Beaver Cr. and south of diagonal road, S ctr. sec. 3, SALEM. Columbiana (1). *Derbyia crassa*? (R).
- Cs-13. Glacial erratic, D. L. Windle farm, west of McCracken Corners, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 20, LISBON. Upper Mercer(?) (1). *Schizophoria resupinoides*? (R).

St. Clair Township:

- Csc-1. Exposures along Bieler Run, N $\frac{1}{2}$ sec. 12, EAST LIVERPOOL NORTH. Vanport (1). OGS 2021. *Mesolobus striatus*? (C), *Wellerella tetrahedra*? (R), *Desmoinesia muricatina* (R), *Composita* sp. (R).
- Csc-2. Exposures along Longs Run, NW $\frac{1}{4}$ sec. 10, EAST LIVERPOOL NORTH. Vanport (1). OGS 2039. *Orbiculoidea missouriensis*? (R), *Derbyia* sp. (R), *Mesolobus obsoletus* (C), *Desmoinesia muricatina* (A), *Antiquatonia portlockiana*? (R), *Composita argentea*? (R), *C. sp.* (A), *Neospirifer cameratus* (R) *Phricodothyris perplexa* (C).

Yellow Creek Township:

- Cyc-4. Abandoned strip mine on east and north sides of hill between Pennsylvania RR. on west and north-south road on east, approx. 500 yds. south of McClain Brick Plant, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, WELLSVILLE. Washingtonville (1). OGS 1831. *Eolissochonetes fragilis* (R), *Mesolobus mesolobus* (R).

Uncertain localities:

- Cuc-1. Uncertain locality, LISBON. Columbiana (1). OGS 1909. *Derbyia* sp. (R), *Mesolobus lioderma* (C), *M. obsoletus* (C), *Desmoinesia muricatina* (A), *Juresania* sp. (R), *Linoproductus* sp. (R).
- Cuc-2. Uncertain locality south of East Palestine, EAST PALESTINE. Dorr Run or Washingtonville? (1). *Lingula carbonaria* (R), *Mesolobus lioderma* (C), *M. obsoletus* (C), *Desmoinesia* sp. (R), *Juresania nebrascensis* (C), *Linoproductus* sp. (R), *Composita subtilita* (R), *Neospirifer cameratus*? (R), *Phricodothyris perplexa* (R).

COSHOCTON COUNTY:

Franklin Township:

- CSf-1. Abandoned (Best?) mine, east side of Muskingum R., due east of Conesville, WILLS CREEK. Washingtonville (1). *Mesolobus mesolobus* (C), *Desmoinesia muricatina* (R), *Echinaria* sp. (R), *Juresania* sp. (R), *Linoproductus* sp. (R), *Composita* sp. (C).
- CSf-2. Abandoned strip mines(?) vicinity of junction of Rtes. 76 and 275A, WILLS CREEK. Washingtonville (1). *Juresania nebrascensis* (R), *Linoproductus* sp. (C), *Composita* sp. (R), *Phricodothyris perplexa* (R).
- CSf-3. Simco-Peabody Coal Co. strip mines east of Conesville in central Franklin Tp., WILLS CREEK. Washingtonville (2). *Desmoinesia muricatina* (A), *Antiquatonia* sp. (C), *Linoproductus echinatus*? (C).

Jackson Township:

- CSj-1. Abandoned borrow pit. approx. 200 ft. west of Rte. 16 and 0.5 mi. south of Rte. 271, RAN-DLE. Upper Mercer (1). *Mesolobus striatus* (C), *Kozlowskia haydenensis* (A), *Antiquatonia portlockiana quadrata* (R), *Composita subtilita*? (R), *C. sp.* (R), *Neospirifer* sp. (R), *Punctospirifer kentuckyensis* (R).
- CSj-2. Abandoned strip mine, sec. 24, CONESVILLE. Washingtonville (1). *Mesolobus mesolobus* (R).

Tuscarawas Township:

- CStu-1. Abandoned Daniel Hudson Mine, approx. 1.0 mi. east of Pleasant Valley School near head of east-west tributary to Muskingum R., sec. 4(?), WILLS CREEK. Washingtonville (1). OGS 6004. *Cleiothyridina orbicularis* (R).

Virginia Township:

- CSv-2. Davis Coal Co. abandoned mine, SE $\frac{1}{4}$ sec. 9, CONESVILLE. Washingtonville (1). *Chonetids* indeterm. (R), *Desmoinesia muricatina* (A), *Antiquatonia portlockiana* (R), *A. sp.* (C), *Linoproductus* sp. (R), *Composita* sp.

- (R), *Punctospirifer kentuckyensis* (R).
- CSv-3. Strip mines, SW $\frac{1}{4}$ sec. 17, CONESVILLE. Washingtonville (3). OGS 6775. *Orbiculoidea meekana*? (R), *Derbyia* sp. (R), *Eolissochonetes fragilis* (?), *Mesolobus mesolobus* (C), *M. lioderma*? (R), *Desmoinesia muricatina* (R), *Juresania nebrascensis* (C), *Antiquatonia portlockiana* (C), *Linoproductus echinatus*? (R), *Cleiothyridina orbicularis* (C), *Composita subtilita* (A), *Phricodothyris perplexa* (C).
- CSv-4. Abandoned strip mines of Simco-Peabody Coal Co., prospect pits and road cuts, S $\frac{1}{2}$ sec. 3, N $\frac{1}{2}$ sec. 8, and NW $\frac{1}{4}$ sec. 9, CONESVILLE. Columbiana, Putnam Hill, Vanport, and Washingtonville (2). *Derbyia* cf. *D. subcircularis* (R), *Leptalosia ovalis* (R), *Desmoinesia muricatina* (A), *Juresania nebrascensis* (A), *Antiquatonia portlockiana* (C), *Reticulatia rugatua* (R), *Linoproductus prattenianus* (C), *L. echinatus* (A), *Wellerella tetrahedra*? (R), *Hustedia mormoni* (R), *Composita subtilita* (A), *C. ovata* (C), *Anthracospirifer rockymontianus* (R), *A. opimus*? (R), *Neospirifer cameratus* (C), *Phricodothyris perplexa* (R).

GUERNSEY COUNTY:

Cambridge Township:

- Gca-2. Exposure in road cut at Georgetown, CAMBRIDGE. Undifferentiated Brush Creek (1). *Juresania nebrascensis pulchra* (R), *Composita* sp. (R), *Beecheria bovidens*? (R).
- Gca-3. Exposure at hilltop between Cambridge and Georgetown, CAMBRIDGE. Cambridge (1). *Echinaria semipunctata* (R).

Millwood Township:

- Gmi-1. Borrow pit on north side of Rte. 265, west of Quaker City, SE $\frac{1}{4}$ sec. 26, QUAKER CITY. Ames (2). *Crania modesta* (R), *Derbyia crassa* (A), *Kozlowskia splendens* (R), *Juresania nebrascensis* (C), *Antiquatonia portlockiana* (R), *Linoproductus prattenianus* (C), *Hustedia mormoni* (A), *Composita subtilita* (A), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (A), *Punctospirifer kentuckyensis amesi* (A).

Oxford Township:

- Go-1. Exposure in road cut on south side of Interstate 70 and east of junction with Rte. 513, NW $\frac{1}{4}$ sec. 25, ANTRIM. Ames (2). *Crania modesta* (R), *Orthotetes conemaughensis* (R), *Derbyia parvicostata* (A), *Leptalosia ovalis* (R), *Hystriculina wabashensis* (C), *Juresania nebrascensis* (A), *Antiquatonia portlockiana* (R), *Linoproductus* cf. *L. platymbonus* (C), *L. sp.* (R), *Wellerella osagensis* (R), *Hustedia mormoni* (A), *Composita subtilita* (A), *Crurithyris planoconvexa* (C), *Neospirifer dunbari* (A), *Punctospirifer kentuckyensis amesi* (A).

Westland Township:

- Gwe-1. John Gress & Sons Quarry, north of Rte. 40 and 0.25 mi. east of New Concord, NEW CONCORD. Cambridge (2). *Lingula carbonaria* (R), *Orbiculoidea missouriensis*? (R), *Meekella striatocostata* (C), *Chonetinella plebeia*

(A), *Kozlowskia splendens* (A), *Echinaria semipunctata* (A), *Pulchratia symmetrica regularis* (C), *Juresania* sp. (R), *Antiquatonia portlockiana* (R), *A. p. crassicostata* (A), *Linoproductus* cf. *L. platyumbonus*? (R), *L. cf. L. magnispinus* (R), *L. sp.* (C), *Composita ovata*? (R), *C. elongata* (R), *Neospirifer latus* (A).

Wills Township:

Gwi-1. Undescribed and uncertain exposure, NE $\frac{1}{4}$ sec. 10, OLD WASHINGTON. Cambridge (1). *Antiquatonia* sp. (R), *Neospirifer dunbari* (R).

HOCKING COUNTY:

Falls Gore Township:

Hfg-5. Abandoned strip mines, Hocking Valley Brick Co., south of east-west road, SE $\frac{1}{4}$ sec. 31, GORE. Lower Mercer (no. of collections uncertain). OGS 7070. *Lingula carbonaria* (R), *Orbiculoidea* sp. (R), *Crania modesta* (R), *Derbyia crassa* (A), *Mesolobus striatus* (A), *Kozlowskia haydenensis* (A), *Desmoinesia muricata* (R), *D. sp.* (R), *Echinaria semipunctata knighti*? (R), *Juresania nebrascensis*? (R), *Antiquatonia portlockiana quadrata* (A), *Linoproductus planiventralis* (C), *L. echinatus* (R), *L. sp.* (R), *Composita subtilita*? (A), *Crurithyris planoconvexa*? (R), *Anthracospirifer occiduus* (A), *Neospirifer gorei* (R), *Punctospirifer kentuckyensis* (A), *Phricodothyris perplexa* (R).

Hfg-6. Abandoned strip mines, NE $\frac{1}{4}$ sec. 31, GORE. Putnam Hill (1). OGS 6760. *Mesolobus striatus* (A), *Kozlowskia haydenensis* (A), *Antiquatonia portlockiana quadrata* (A).

Hfg-7. Abandoned railroad cut, just southwest of Webb Summit, sec. 30, GORE. Upper Mercer (1). OGS 11964? *Derbyia* sp. (R), *Kozlowskia haydenensis* (R), *Composita* sp. (R), *Anthracospirifer rockymontanus* (R), *Phricodothyris perplexa* (R).

Green Township:

Hg-1. Undescribed and uncertain exposure, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, GORE. Undifferentiated Pottsville(?) (1). *Lingula carbonaria* (A), *Punctospirifer kentuckyensis* (R).

Hg-2. Shale between two ironstones, north side Rte. 33, SW $\frac{1}{4}$ sec. 7, UNION FURNACE. Lower Mercer(?) (1). *Lingula carbonaria* (R), *Orbiculoidea* sp. (R).

Hg-3. Undescribed and uncertain exposure between Rtes. 278 and 595 junction and Greendale (formerly Kachelmacher) in what would be secs. 3 and 4, GORE. Putnam Hill (1). *Composita* sp. (R).

Starr Township:

Hs-3. Slump behind County Garage, 0.5 mi. south of Union Furnace Post Office, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, UNION FURNACE. Lower Mercer (1). OGS 12876. *Crania modesta* (R), *Mesolobus striatus* (A), *Kozlowskia haydenensis* (A), *Antiquatonia portlockiana quadrata* (R), *Linoproductus planiventralis* (R), *Composita subtilita*? (C), *C. sp.* (R), *Anthracospirifer occiduus* (A), *Punctospirifer kentuckyensis* (A).

Hs-4. Exposures along relocated Rte. 33, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 12, UNION FURNACE. Undifferentiated Pottsville (1). *Orbiculoidea missouriensis* (R), *O. capuliformis* (C), *Linoproductus* sp. (R), *Composita ovata*? (R).

Hs-5. Abandoned strip mine, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, UNION FURNACE. Dorr Run (1). *Linoproductus* sp. (R).

Hs-6. Abandoned strip mines south of Hocking R., N ctr. sec. 5, UNION FURNACE. Dorr Run (1). *Derbyia* sp. (C), *Linoproductus prattenianus* (C), *Composita* sp. (A).

Hs-7. Exposure along east side of north-south road, W $\frac{1}{2}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 11, UNION FURNACE. Lower Mercer and Dorr Run (1). OGS 9297 and 9306. *Lingula carbonaria* (C), *Composita subtilita* (R), *C. sp.* (R), *Anthracospirifer occiduus* (C).

Ward Township:

Hw-12. Undescribed and uncertain exposure, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, NEW STRAITSVILLE. Dorr Run (1). *Lingula carbonaria* (A), *Orbiculoidea missouriensis* (C).

Hw-13. Abandoned strip mine, L. & M. (Liden) Coal Co. (type locality for Dorr Run), SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 31, UNION FURNACE. Dorr Run (1). *Lingula carbonaria* (A), *Orbiculoidea missouriensis*? (C).

Uncertain locality:

Huc-1. Uncertain exposure(s) near Carbon Hill, GORE, NELSONVILLE, and NEW STRAITSVILLE(?). Putnam Hill(?). *Orbiculoidea meekana*? (R), *Lindstroemella patula* (R), *Krotovia* sp. (R).

HOLMES COUNTY:

Berlin and Hardy Townships:

HOb-1 Strip mine, W $\frac{1}{2}$ sec. 3 (Berlin), and E $\frac{1}{2}$ sec. 4 (Hardy), BERLIN. Putnam Hill (1). OGS

HOH-1. 5718. *Desmoinesia muricata* (A), *Composita* sp. (C), *Neospirifer cameratus* (R), *Phricodothyris perplexa* (C), *Beecheria bovidens* (R).

Clark Township:

HOc-1. Shale pit west side Rte. 557, approx. 0.5 mi. north of Baltic, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, BALTIC. Putnam Hill (1). *Anthracospirifer occiduus* (R), *Neospirifer cameratus*? (R).

HOc-2. General Clay Products Co. shale pit, approx. 0.5 mi. northeast of Baltic, SE $\frac{1}{4}$ sec. 25, BALTIC. Putnam Hill (1). *Desmoinesia muricata* (A), *Antiquatonia* sp. (R), *Linoproductus* sp. (C), *Composita* sp. (C).

Hardy Township:

HOH-1. Combined with HOb-1 (which see).

Richland Township:

HOH-1. Exposure on county line road, SW $\frac{1}{4}$ sec. 22, SPRING MOUNTAIN. Lower Mercer (1). *Kozlowskia haydenensis* (R), *Desmoinesia muricata* missouriensis (C), *Neospirifer cameratus*? (R).

Walnut Creek Township:

HOWC-1. Exposure in stream channel, NE $\frac{1}{4}$ sec. 23,

SUGARCREEK. Lower Mercer (1). OGS 5951. *Anthracospirifer occiduus* (R), *Neospirifer cameratus*? (R).

Uncertain locality:

HOuc-1. Undescribed and uncertain exposure, northeast of Killbuck, MILLERSBURG. Washingtonville (1). *Mesolobus mesolobus* (C).

JACKSON COUNTY:

Franklin Township:

Jf-1. Undescribed and uncertain exposure, approx. 3.0 mi. south of Jackson, JACKSON, OAK HILL, PETERSBURG, or WELLSTON. Vanport (no. of collections uncertain). *Composita argentea* (A), *Phricodothyris perplexa* (A), *Beecheria bovidens* (R).

Hamilton Township:

Jh-1. Exposure in channel of tributary to Little Scioto R. below house of Philip Meldick, ctr. sec. 14 (Morningstar's locality 1), PETERSBURG. Harrison (1). OGS 3580. *Oehlertella stoutella* (A).

Milton Township:

Jmi-1. Exposure along Coal Run(?), NE¼ sec. 23, MULGA. Putnam Hill (1). *Phricodothyris perplexa* (R).

JEFFERSON COUNTY:

Cross Creek Township:

Jecc-1. Exposure east of Pennsylvania RR. cut at Tunnel 6, NE¼ sec. 34, STEUBENVILLE WEST. Cambridge (1). OGS 1126. *Echinaria semipunctata* (C), *Linoproductus* sp. (R).

Jecc-2. Exposure along Permian Run south of Sinclair Ave., NW¼ sec. 5, STEUBENVILLE WEST. Ames (1). OGS 1129. *Juresania nebrascensis* (C), *Antiquatonia portlockiana* (C), *Linoproductus prattenianus* (R), *Neospirifer dunbari* (R).

Salem Township:

JEs-1. Exposure in strip mine on east side of Unionport Rd., south of Annapolis, SW¼ sec. 32, RICHMOND. Ames (1). OGS 1197. *Enteleles hemiplicatus*? (R), *Derbyia parvicostata* (R), *Composita* sp. (R), *Crurithyris planoconvexa* (R), *Neospirifer dunbari* (R).

JEs-2. Exposure in strip mine on east side of Annapolis-East Springfield Rd., sec. 34 or 35, RICHMOND. Ames (1). *Neospirifer dunbari* (R).

Saline Township:

JEs-1. Undescribed exposure, W ctr. sec. 32, WELLSVILLE. Ames (1). *Hystriculina wabashensis* (R), *Juresania nebrascensis* (R), *Linoproductus* cf. *L. platyumbonus* (R), *Composita subtilita*? (R), *Neospirifer* sp. (R), *Punctospirifer kentuckyensis amesi* (R).

JEs-2. Exposure at McClain Firebrick Co., 1.0 mi. southeast of Irondale, SW¼NW¼ sec. 19, and SE¼NE¼ sec. 25, WELLSVILLE. Vanport (1). *Juresania nebrascensis* (R), *Linoproductus* sp. (R), *Wellerella tetrahedra*? (R), *Cleiothyridina orbicularis* (R), *Composita* sp. (A).

Wayne Township:

JEwa-1. Cut on north side Pennsylvania RR., east of road junction at elev. no. 985, approx. 1.5 mi. north of Bloomingdale, SE¼ sec. 24, SMITHFIELD. Ames (1). *Enteleles hemiplicatus*? (R), *Rhipidomella carbonaria* (R), *Derbyia crassa* (A), *Neochonetes semiacanthus* (A), *Hystriculina wabashensis* (A), *Juresania nebrascensis* (C), *Antiquatonia portlockiana* (R), *Linoproductus prattenianus* (R), *Wellerella osagensis* (A), *Hustedia mormoni* (A), *Composita argentea* (A), *C. ovata* (A), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (C), *Punctospirifer kentuckyensis amesi* (C), *Phricodothyris perplexa* (R).

JEwa-2. Exposure at bend in Rte. 152, SW¼ sec. 12, SMITHFIELD. Ames (1). OGS 926. *Krotovia* sp. (R), *Hystriculina wabashensis* (A), *Juresania nebrascensis* (R), *Antiquatonia* sp. (R), *Linoproductus* sp. (R), *Hustedia mormoni* (R), *Composita subtilita*? (A), *Crurithyris planoconvexa* (A), *Neospirifer dunbari* (R).

LAWRENCE COUNTY:

Decatur Township:

Ld-1. Marquette Cement Co. quarries, secs. 20, 29, 30, 31, and 32, PEDRO. Vanport (1). OGS 4733, 4749, and 4762. *Composita* sp. (C).

Lawrence Township:

Ll-1. Abandoned slope mine, east side of Rte. 141, ctr. sec. 10, KITTS HILL. Cambridge (1). OGS 4014. *Chonetinella flemingi* (R), *Echinaria* sp. (R), *Antiquatonia portlockiana crassicosata* (C), *Neospirifer latus* (C).

Mason Township:

Lm-1. Abandoned strip mine, Buck Cr., SW¼SW¼ sec. 5, WATERLOO. Cambridge (1). *Chonetinella flemingi* (A), *Echinaria semipunctata* (R), *Juresania nebrascensis* (R), *Antiquatonia portlockiana crassicosata* (A), A. sp. (R), *Composita ohioense* (A), *Neospirifer latus* (R).

Symmes Township:

Ls-1. Abandoned strip mines, Belville Mining Co., Inc., south side of Johns Cr., sec. 35, SHERITT. Cambridge (2). OGS 4706. *Crania modesta* (R), *Isogramma millepunctata* (R), *Chonetinella flemingi* (A), *C. verneuliana* var. (R), *Desmoinesia muricata* (R), *Echinaria semipunctata* (A), *Juresania nebrascensis* (C), *Antiquatonia portlockiana crassicosata* (A), *Linoproductus prattenianus*? (R), *L. echinatus* (R), *Composita ohioense* (A), *Neospirifer latus* (A).

Union Township:

Lu-1. Exposure along road, N¼NW¼ sec. 32, HUNTINGTON. Ames (1). *Neochonetes granulifer* (A).

Lu-2. Exposure along Symmes Cr. Valley, SE¼NE¼ sec. 29, HUNTINGTON. Cambridge (1). OGS 5198. *Echinaria semipunctata* (R).

Uncertain locality:

Luc-1. Undescribed and uncertain exposure near Arabia, WATERLOO. Cambridge? (1). *Der-*

byia sp. (R), *Juresania nebrascensis* (C), *Antiquatonia portlockiana crassicosata* (A), *Composita elongata*? (C).

LICKING COUNTY:

Hopewell Township:

Llho-1. Abandoned cannel coal mine, west side of north-south road, approx. 0.2 mi. north of first road junction on Flint Ridge Rd. west of Flint Ridge Pk., GLENFORD. Lower Mercer (1). OGS 6294. *Derbyia* sp. (R), *Mesolobus striatus* (C), *Juresania nebrascensis inflata* (R), *Linoproductus* sp. (R), *Composita* sp. (R), *Anthracospirifer occiduus* (C), *Punctospirifer kentuckyensis* (R), *Phricodothyris perplexa* (R).

Llho-2. Undescribed and uncertain exposure near townhouse at BM 1143 on Flint Ridge Rd., approx. 0.1 mi. west of first road junction to east and approx. 1.3 mi. by road west of road junction at elev. no. 1098, GRATIOT. Vanport (1). *Derbyia crassa* (C), *Mesolobus striatus* (R), *Echinaria semipunctata knighti* (R), *Juresania nebrascensis* (C), *J.* sp. (R), *Antiquatonia portlockiana*? (C), *Linoproductus* sp. (C), *Phricodothyris perplexa* (R).

Uncertain locality:

Lluc-1. Undescribed and uncertain locality, Flint Ridge. Lower Mercer (1). *Mesolobus striatus* (C), *Juresania* sp. (R), *Antiquatonia portlockiana quadrata*? (R), *Linoproductus planiventralis* (C), *L.* sp. (R), *Neospirifer goreii* (R), *Phricodothyris perplexa* (R).

MAHONING COUNTY:

Canfield Township:

Mc-1. Abandoned strip mine, north side of Rte. 224, approx. 2.0 mi. west of Canfield, CANFIELD. Putnam Hill (2). *Derbyia crassa*? (R), *Mesolobus obsoletus* (C), *Reticulatia rugata* (R), *Linoproductus prattenianus*? (R), *L.* sp. (R), *Wellerella tetrahedra* (R), *Hustedia mormoni* (R), *Composita subtilita* (A), *C. elongata* (R), *Neospirifer cameratus* (A), *Phricodothyris perplexa* (R).

Mc-2. Abandoned Leb Coal Co. strip mine, east side of Crory Rd., 0.25 to 0.5 mi. south of Rte. 224, CANFIELD. Putnam Hill (2). *Lingula lemniscata*? (R), *Crania modesta* (R), *Derbyia crassa* (C), *Mesolobus mesolobus* (R), *M. obsoletus* (C), *Chonetinella crassiradiata* (R), *chonetids* indetermin. (R), *Krotovia* sp. (R), *Desmoinesia muricata* (A), *Reticulatia rugata* (C), *Wellerella tetrahedra*? (R), *Composita subtilita* (C), *Crurithyris planoconvexa* (R), *Neospirifer cameratus* (R).

Mc-3. Exposures along tributary on south side of Indian Run, between Christ's Mission Camp and Optimist Club Boys Camp, 0.5 mi. east of Raccoon Rd. and just north of Leffingwell Rd., YOUNGSTOWN. Putnam Hill (1). OGS 1911. *Lingula carbonaria* (R), *Derbyia crassa* (R), *Mesolobus obsoletus* (R), *Desmoinesia muricata* (R), *Reticulatia rugata*? (R), *Composita* sp. (R).

Mc-4. Exposure (abandoned quarry?) along Sawmill Cr. near County Home, CANFIELD. Lower

Mercer (1). OGS 6908. *Kozlowskia haydenensis* (C), *Linoproductus* sp. (R), *Cleiothyridina orbicularis crassalamellosa* (C), *Anthracospirifer rockymontanus* (R), *Neospirifer* sp. (R), *Phricodothyris perplexa* (R).

Coitsville Township:

Mco-1. Exposure along Dry Run at spillway to Lake McKelvey, CAMPBELL. Quakertown (1). OGS 5030. *Orbiculoidea meekana* (C).

Ellsworth Township:

Me-1. Abandoned strip mines, east side of Rte. 45 north of Bowmans Corners and south of Leffingwell Rd., SALEM. Putnam Hill (1). OGS 6912. *Mesolobus striatus* (C), *Desmoinesia muricata* (C), *Reticulatia rugata* (C), *Linoproductus echinatus*? (R), *L.* sp. (C), *Composita subtilita* (C).

Green Township:

Mg-2. Abandoned shaft mine New Salem Coal Co. (J. Pascola), south side Rte. 14A, near head of ravine southwest of Millville, SW¼ sec. 33, SALEM. Columbiana (1). OGS 3776. *Lingula carbonaria* (R), *Orbiculoidea missouriensis* (R), *Mesolobus lioderma* (R), *Desmoinesia muricata* (C), *Echinaria semipunctata knighti* (R), *Juresania nebrascensis* (R), *Reticulatia rugata* (R), *Wellerella tetrahedra*? (R), *Composita subtilita* (C), *C.* sp. (R), *Phricodothyris perplexa* (R).

Mg-3. Exposure along small stream on Ira Unger farm, approx. 100 yds. east of Knauf Rd., NW¼ sec. 4, SALEM. Putnam Hill (2). OGS 15068. *Lingula carbonaria* (R), *Mesolobus obsoletus* (C), *Desmoinesia muricata* (A), *Crurithyris planoconvexa* (R).

Mg-4. Abandoned Nick Weingart Mine, along north-east side of Middle Fork Little Beaver Cr., E ctr. sec. 7, SALEM. Putnam Hill (2). OGS 5608. *Derbyia crassa*? (R), *Mesolobus striatus* (R), *Desmoinesia muricata* (A), *Juresania nebrascensis* (C), *Reticulatia rugata* (C), *Linoproductus prattenianus* (R), *L.* sp. (R), *Hustedia mormoni* (R), *Composita argentea* (R), *Composita ovata*? (R), *Phricodothyris perplexa* (R).

Mg-5. Exposure along stream and in two shallow pits on A. V. Kenreigh farm, NW¼ sec. 17, and NE¼ sec. 18, SALEM. Putnam Hill (1). OGS 15069. *Lingula carbonaria* (C), *Mesolobus obsoletus* (C), *Wellerella tetrahedra* (R).

Mg-6. Abandoned New Albany Coal Co. (later Davis Coal Co.) strip mine, east side Rte. 45 and north of South Range Rd. (Rte. 165), SW¼ sec. 17, and S ctr. sec. 18, SALEM. Columbiana (2). OGS 15070. *Trigonoglossa kentuckyensis* (R), *Orbiculoidea missouriensis* (R), *Crania modesta* (R), *Derbyia* sp. (R), *Mesolobus mesolobus* (A), *M. lioderma* (A), *Chonetinella crassiradiata* (R), *Desmoinesia muricata* (A), *Juresania nebrascensis* (C), *Reticulatia rugata* (C), *Linoproductus prattenianus*? (R), *Cleiothyridina orbicularis* (R), *Composita subtilita* (A), *Neospirifer cameratus* (C), *Phricodothyris perplexa* (C).

Mg-7. Abandoned H. L. Daugherty slope mine, south

- side of South Range Rd. (Rte. 165), NE cor. sec. 19, SALEM. Columbiana (1). OGS 3770. *Lingula carbonaria* (R), *Orthotetes* sp. (R), *Derbyia crassa* (R), *Mesolobus lioderma* (A), *Desmoinesia muricatina* (A), *Juresania nebrascensis* (R), *Reticulatia rugatia* (R), *Linoproductus prattenianus*? (R), *Composita subtilita* (R).
- Mg-9. Abandoned Silver Creek Mine and exposure along stream parallel to and south of South Range Rd. (Rte. 165), NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 21, SALEM. Columbiana (1). OGS 3772. *Mesolobus lioderma* (A).
- Mg-10. Abandoned Ed. Shepherd Mine, east side of Middle Fork Little Beaver Cr., N ctr. sec. 33, SALEM. Columbiana (1). OGS 3775. *Lingula carbonaria* (R), *Orbiculoidea missouriensis* (R), *Derbyia crassa*? (R), *Mesolobus lioderma* (A), *Desmoinesia muricatina* (R), *Juresania nebrascensis* (C), *Reticulatia rugatia* (C), *Composita subtilita*? (C), *C. sp.* (R), *Neospirifer cameratus*? (R), *Phricodothyris perplexa* (C).
- Mg-11. Abandoned J. A. Stouffer Mine (type locality for Washingtonville), east of reservoir on Cherry Valley Run and north of Rte. 14A, northeast edge of Washingtonville, SW $\frac{1}{4}$ sec. 36, SALEM. Washingtonville (1). OGS 1710. *Eolissochonetes fragilis*? (R), *Mesolobus mesolobus*? (R).
- Mg-12. Abandoned mines formerly operated by A. L. Houts and Ed. Zimmerman, west edge of New Albany and under present location of Rte. 62, NW $\frac{1}{4}$ sec. 20, SALEM. Columbiana (1). *Lingula carbonaria* (C).
- Mg-13. Abandoned deep mine in ravine, W ctr. sec. 28, SALEM. Columbiana (1). *Orbiculoidea missouriensis* (R), *Lingula carbonaria* (R).
- Mg-14. Abandoned J. C. Matzenbaugh Mine in ravine north of Rte. 14A, SW $\frac{1}{4}$ sec. 35, SALEM. Washingtonville (1). OGS 1715. *Lingula carbonaria* (C).
- Mg-15. Abandoned John Walters (National) shaft mine in second tributary valley on west side of Cherry Valley Run south of Garfield Rd. and near high tension line and farm buildings, N ctr. SE $\frac{1}{4}$ sec. 35, SALEM. Columbiana (1). *Composita* sp. (R), *Phricodothyris perplexa* (R).
- Poland Township:
- Mp-1. Abandoned quarry with lake managed by Lowellville Rod and Gun Club, southwest of Lowellville, east of Quarry Rd. and north of Rte. 224, CAMPBELL. Vanport (4). OGS 5014. *Chonetinella crassiradiata* (R), *Kozlowskia splendens* (R), *Desmoinesia muricatina missouriensis*? (R), *Juresania* sp. (R), *Hustedia mormoni* (A), *Cleiothyridina orbicularis* (R), *Composita ovata* (C), *C. argentea*? (C), *C. girtyi* (A), *Anthracospirifer rockymontanus* (R), *Phricodothyris perplexa* (A).
- Mp-2. Carbon Limestone Co. quarries, 0.75 mi. south of Rte. 224 and just west of Ohio-Pennsylvania line in vicinity of Kansas Corners, CAMPBELL. Vanport (2). OGS 5541. *Phricodothyris perplexa* (A).
- Mp-3. Exposures along Furnace (Grindstone) Run (type locality for Lowellville), south of Lowellville and Mahoning R., east of Kennedy Rd., CAMPBELL. Lowellville (Poverty Run), Lower and Upper Mercer (4). OGS 5014. *Derbyia* sp. (C), *Rugosochonetes delicatus* (C), *Mesolobus striatus* (C), *Kozlowskia haydensensis* (A), *Desmoinesia muricatina* (A), *Antiquatonia* sp. (R), *Linoproductus* sp. (R), *Anthracospirifer rockymontanus*? (R), *A. occidentus* (R), *Phricodothyris perplexa* (R).
- Mp-4. Exposure along Yellow Cr. between Rte. 224 bridge and Lake Hamilton, opposite cemetery on east and Rte. 616 on west, Poland, CAMPBELL. Lower Mercer (1). OGS 5027. *Mesolobus striatus* (R), *Anthracospirifer rockymontanus* (C), *A. occidentus* (C).
- Smith Township:
- Ms-1. Undescribed and uncertain exposure north of Courtney Rd. and between Bandy and Oyster Rds., ALLIANCE. Putnam Hill (1). Chonetids indetermin. (R).
- Ms-2. Alliance Stone Co. strip mine, southwest of junction of Martin and Middletown Rds., NE $\frac{1}{4}$ sec. 18, ALLIANCE. Putnam Hill (1). OGS 15124. *Mesolobus obsoletus* (C), *Desmoinesia muricatina* (C), *Hustedia mormoni* (R), *Composita* sp. (R).
- Ms-3. Exposure, probably in strip mine northwest of junction of Martin and Middletown Rds., SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 7, ALLIANCE. Undifferentiated Allegheny (probably Putnam Hill) (1). *Mesolobus mesolobus* (R), *Desmoinesia muricatina* (R).
- Ms-4. City Asphalt & Paving Co. quarry, east of Martin Rd. and north of Courtney Rd., NW $\frac{1}{4}$ sec. 20, ALLIANCE. Putnam Hill (1). *Desmoinesia muricatina* (A).
- Ms-5. Abandoned Sunnyside Mining Co. strip mine, west of Westville and north of Rte. 62, SE $\frac{1}{4}$ sec. 35, ALLIANCE. Columbiana (1). OGS 2160. *Desmoinesia muricatina missouriensis* (R), *Composita ovata* (R), *Neospirifer cameratus* (C), *Phricodothyris perplexa* (R).
- MORGAN COUNTY:
- Bloom Township:
- MOB-1. Exposures along Opossum Hollow, SE $\frac{1}{4}$ sec. 25, ROKEBY LOCK. Ames (1). OGS 10380. *Derbyia* sp. (R), *Neochonetes semiacanthus* (C), *Kozlowskia splendens* (A), *Pulchratia symmetrica regularis* (R), *Juresania nebrascensis pulchra* (R), *Linoproductus* sp. (C), *Neospirifer dunbari*? (R).
- MOB-2. Undescribed and uncertain exposure, SE $\frac{1}{4}$ sec. 5, PHILO. Portersville(?) (1). OGS 10379. *Crurithyris planoconvexa* (C).
- Deerfield Township:
- MOd-1. Exposure along valley of Island Run, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, ROKEBY LOCK. Undifferentiated Brush Creek (1). OGS 7837. *Juresania nebrascensis pulchra* (R), *Antiquatonia portlockiana* (R), *Linoproductus prattenianus* (C), *L. sp.* (R), *Composita ovata* (C), *Neospirifer dunbari* (C).
- Homer Township:
- MOh-1. Same as At-4 (which see).
- MOh-2. Exposure in pipeline ditch (now covered)

NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 19, JACKSONVILLE.
Portersville (1). OGS 7862. *Neospirifer* sp.
(R).

Malta Township:

MOm-1. Undescribed and uncertain exposure, ctr. sec. 10, MCCONNELSVILLE. Ames (1). OGS 10381. *Hystericulina wabashensis* (R), *Antiquatonia portlockiana* (R).

York Township:

MOy-1. Exposure, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, DEAVERTOWN. Portersville (1). *Chonetinella alata* (A), *C. verneuliana* var. (R), *Neospirifer dunbari* (R), *N. latus*? (R).

MOy-2. Undescribed exposure, E $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 35, DEAVERTOWN. Ames (1). *Antiquatonia portlockiana* (C), *Linoproductus* cf. *L. platyumbonus* (R).

MUSKINGUM COUNTY:

Blue Rock Township:

MUbr-1. Exposures along Coal Hollow, sec. 22, RURALDALE. Ames (1). *Neochonetes semiacanthus* (A), *Juresania nebrascensis* (R), *Antiquatonia* sp. (R), *Linoproductus* sp. (C).

MUbr-2. Exposures along Rte. 340, 0.4 mi. west-northwest of Ruraldale, W ctr. sec. 26, RURALDALE. Gaysport and Skelley (1). *Neochonetes semiacanthus*? (R).

MUbr-3. Undescribed and uncertain exposure, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 26, RURALDALE. Undifferentiated Brush Creek (1). *Juresania nebrascensis* (C), *Antiquatonia portlockiana* (R), *Linoproductus* sp. (C).

MUbr-4. Undescribed and uncertain exposure, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, PHILO. Gaysport (1). OGS 578. *Juresania nebrascensis* (R), *Antiquatonia portlockiana* (C), *Linoproductus platyumbonus* (C), *Composita* sp. (R), *Neospirifer dunbari* (R).

Cass Township:

MUc-1. Exposure along Rte. 117, approx. 3.0 mi. southeast of Fazeysburg, DRESDEN. Lower Mercer (1). OGS 1658? *Trigonoglossa kentuckyensis* (C), *Mesolobus striatus* (R), *Kozlowskia haydenensis* (A), *Desmoinesia muricata* (C), *Juresania* sp. (R), *Linoproductus planiventralis* (R), *L. sp.* (C), *Composita* sp. (R).

MUc-2. Exposures along the Highlands and road between Dresden and Fazeysburg, DRESDEN. Putnam Hill and Vanport (1). OGS 770. *Reticulatia rugatia* (R), *Composita argentea* (C), *Phricodothyris perplexa* (R).

Clay Township:

MUcl-1. Abandoned Prison Brick Plant strip mine, northeast edge of Roseville, NW $\frac{1}{4}$ sec. 3, CROOKSVILLE. Vanport (2). OGS 8373. *Mesolobus striatus* (A).

Falls Township:

MUf-1. Exposure along ravine, northeast side of Licking R. and south of Rte. 146 just south-east of road junction at elev. no. 876, approx. 2.0 mi. northwest of Dillon Falls, ZANESVILLE WEST. Lowellville (Poverty Run) (2).

OGS 687. *Rugosochonetes delicatus* (A), *Antiquatonia portlockiana* (R).

MUf-2. Exposure on north side of Dillon Reservoir, approx. 0.8 mi. northwest of junction of Big Run and Licking R., DRESDEN. Putnam Hill (1). OGS 682. *Composita subtilita*? (C), *Anthracospirifer rockymontanus* (R), *Neospirifer cameratus*? (R), *Phricodothyris perplexa* (R).

Harrison Township:

MUha-1. Exposures along Cedar Run, secs. 31 and 32, PHILO. Portersville (1). *Derbyia* sp. (R), *Chonetinella alata* (A), *Composita ovata*? (R), *Crurithyris planoconvexa* (R).

Hopewell Township:

MUho-1. Exposure along ravine west-southwest of Glen Kiefer farm buildings near section line, N $\frac{1}{2}$ sec. 18, GRATIOT. Lowellville (Poverty Run) (1). *Rhipidomella carbonaria* (C), *Derbyia crassa* (A), *D. sp.* (C), *Rugosochonetes delicatus* (C), *Antiquatonia* sp. (C), *Linoproductus planiventralis*? (R).

MUho-3. Abandoned Porter Bros. or G. L. Porter mine, south of Hopewell (Coaldale), GRATIOT. Vanport (1). OGS 433. *Mesolobus striatus* (A), *Echinaria semipunctata knighti* (R), *Juresania nebrascensis* (R), *Antiquatonia portlockiana* (R), *A. sp.* (R), *Linoproductus* sp. (A), *Phricodothyris perplexa* (C).

MUho-4. Undescribed and uncertain exposure. Vanport (1). *Mesolobus obsoletus* (A), *Echinaria semipunctata knighti* (R), *Reticulatia rugatia* (R), *Linoproductus* sp. (R), *Composita* sp. (R).

MUho-5. Exposure in stream bed (type locality for Poverty Run), SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, GRATIOT. Poverty Run (1). OGS 421. *Derbyia* sp. (C), *Linoproductus* sp. (R), *Composita* sp. (R), *Crurithyris planoconvexa* (C), *Anthracospirifer occiduus*? (A), *Punctospirifer kentuckyensis* (R).

MUho-6. Undescribed and uncertain exposure, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, GRATIOT. Vanport (1). *Kozlowskia splendens*? (R), *Composita argentea*? (C).

MUho-7. Exposure in ravine on east side of north-south road, NE $\frac{1}{4}$ sec. 18, GRATIOT. Boggs and Lower Mercer (1). OGS 424. *Juresania nebrascensis inflata*? (C), *Antiquatonia portlockiana quadrata* (R), *Linoproductus planiventralis* (C), *Anthracospirifer occiduus* (A), *Composita subtilita*? (R).

Madison Township:

MUma-1. Exposure along Rte. 666, approx. 1.0 mi. north of Ellis Dam, ADAMSVILLE. Putnam Hill (1). *Mesolobus striatus* (C), *Kozlowskia haydenensis* (C), *Composita elongata* (R), *C. argentea* (A).

MUma-2. Exposure at Rte. 666 bridge over small stream opposite Beech Run, ADAMSVILLE. Lower Mercer (1). OGS 522. *Linoproductus* sp. (R), *Anthracospirifer rockymontanus* (R).

Muskingum Township:

MUMu-1. Abandoned strip mines along north-south road, approx. 4.0 mi. south of Dresden, DRES-

- DEN. Washingtonville (3). *Orbiculoidea* sp. (R), *Lindstroemella patula* (R), *Derbyia crassa* (C), *Mesolobus mesolobus* (A), *M. sp.* (R), *Desmoinesia muricata* (R), *Juresania nebrascensis* (A), *Antiquatonia* sp. (R), *Reticulatia rugata* (R), *Linoproductus echinatus?* (A), *L. sp.* (A), *Composita subtilita* (A), *C. ovata* (R), *Phricodothyris perplexa* (A).
- MUmu-2. Undescribed and uncertain exposure, NW¼ SW¼ sec. 12, DRESDEN. Putnam Hill (1). See OGS 718. *Reticulatia rugata* (C), *Composita girtyi* (C), *C. sp.* (R), *Neospirifer cameratus* (R), *Phricodothyris perplexa* (A), *Beecheria bovidens* (R).
- Newton Township:
- MUn-1. Exposure above Maxville Limestone mine, Columbia Cement Plant, W ctr. sec. 20, CROOKSVILLE. Lower Mercer (1). OGS 382. *Derbyia crassa* (C), *Mesolobus striatus* (A), *Kozlowskia haydenensis* (A), *Desmoinesia muricata* (A), *Antiquatonia portlockiana quadrata* (R), *Composita subtilita* (A), *Anthracospirifer occiduus?* (A).
- MUn-2. Undescribed and uncertain exposure, SE¼ NW¼ sec. 30, CROOKSVILLE or FULTON-HAM. Putnam Hill (1). *Orbiculoidea capuliformis* (R), *Mesolobus striatus* (R), *Linoproductus* sp. (C).
- MUn-3. Abandoned quarry, west side former Rte. 75 (now relocated approx. 0.1 mi. west of this location as Rte. 93), NE¼SE¼ sec. 33, CROOKSVILLE. Putnam Hill (1). *Cleiothyridina orbicularis* (R), *Mesolobus striatus* (C), *Composita argentea* (C), *C. sp.* (C), *Neospirifer* sp. (R), *Phricodothyris perplexa* (A).
- MUn-4. Undescribed and uncertain exposure, SW¼ NW¼ sec. 34, CROOKSVILLE. Putnam Hill (1). OGS 376 or 398? *Neospirifer cameratus?* (R).
- Springfield Township:
- MUsp-1. Exposure at Dugway along Muskingum Ave. at Putnam Hill (type locality for Putnam Hill), west side of Muskingum R., Zanesville, NE¼ sec. 1, ZANESVILLE WEST. Putnam Hill (3). OGS 788. *Mesolobus mesolobus?* (R), *M. striatus* (A), *Desmoinesia muricata* (A), *Juresania nebrascensis* (C), *Antiquatonia portlockiana?* (R), *A. sp.* (R), *Linoproductus* sp. (R), *Composita argentea* (A), *C. elongata* (R), *C. girtyi* (R), *Anthracospirifer rockymontanus* (C), *Neospirifer cameratus* (C), *Phricodothyris perplexa* (A).
- MUsp-2. Exposures in channels of Licking and Muskingum Rivers at Y Bridge, Zanesville, NE¼ sec. 1, ZANESVILLE WEST. Lower Mercer (1). OGS 788. *Kozlowskia haydenensis* (C), *Desmoinesia muricata* (A), *Echinaria* sp. (R), *Antiquatonia portlockiana quadrata* (R), *Linoproductus* sp. (R), *Composita* sp. (R), *Anthracospirifer occiduus?* (R).
- Union Township:
- MUu-1. Undescribed and uncertain exposure, NE¼ NW¼ sec. 7, NORWICH. Portersville (1). See OGS 13600. *Derbyia* sp. (C), *Chonetinella alata* (A), *Desmoinesia* sp. (R), *Linoproductus* sp. (R), *Crurithyris planoconvexa* (A).
- MUu-2. Exposure along tributary to Crooked Cr., west of Richard Rice (later Tony Fazekas) farm buildings, 1.5 mi. south of New Concord (Condit's locality 43), NEW CONCORD. Ames (1). *Neochonetes semiacanthus* (A), *Echinaria* sp. (R), *Juresania nebrascensis* (A), *Antiquatonia portlockiana* (A), *Linoproductus prattenianus* (C), *L. sp.* (C), *Composita subtilita?* (C), *C. sp.* (R), *Neospirifer dunbari* (A).
- MUu-3. Abandoned mine on A. N. Daly farm, NE¼ SE¼ sec. 5, NORWICH. Portersville (1). OGS 10385. *Derbyia* sp. (C), *Linoproductus* sp. (R).
- MUu-4. Exposure along road, approx. 1.0 mi. northwest of Norwich, NW¼SW¼ sec. 4, NORWICH. Ames (1). *Derbyia* sp. (C), *Neospirifer* sp. (R).
- Washington Township:
- MUwa-1. Exposures in channel of Blount Run, approx. 1.0 mi. east of Gilbert and above (uphill) abandoned road bridge, ADAMSVILLE. Lower Mercer and Putnam Hill (1). OGS 620. *Derbyia* sp. (R), *Mesolobus striatus* (R), *Kozlowskia haydenensis* (C), *Juresania nebrascensis* (R), *Antiquatonia portlockiana quadrata* (A), *A. sp.* (R), *Reticulatia rugata* (R), *Linoproductus* sp. (R), *Cleiothyridina orbicularis* (R), *Composita subtilita* (C), *C. girtyi* (A), *Anthracospirifer rockymontanus* (R), *Neospirifer goreii* (R), *Phricodothyris perplexa* (A).
- MUwa-2. Exposure in tributary channel at bridge, east side of Muskingum R., approx. 2.0 mi. northeast of Mill Run and 0.3 mi. northeast of BM 704, ZANESVILLE EAST. Lower Mercer (1). OGS 631. *Derbyia* sp. (R), *Mesolobus striatus* (C), *Kozlowskia haydenensis* (A), *Desmoinesia muricata?* (R), *Antiquatonia portlockiana quadrata* (R), *Phricodothyris perplexa* (R).
- MUwa-3. Pennsylvania RR. cut, east side Muskingum R., south of Gilbert, ADAMSVILLE. Putnam Hill (1). *Derbyia* sp. (R), *Mesolobus obsoletus* (A), *Desmoinesia muricata* (C), *Linoproductus* sp. (R), *Composita* sp. (R).
- MUwa-4. Abandoned strip mines, Painter Hollow, east of Ellis Dam on Muskingum R., ADAMSVILLE. Washingtonville (2). *Eolissochonetes fragilis* (A), *Mesolobus mesolobus* (R), *Linoproductus echinatus?* (C).
- MUwa-5. Exposures in ravine, east side of Muskingum R. opposite Ellis, ADAMSVILLE. Upper Mercer and Putnam Hill (1). *Kozlowskia haydenensis* (R), *Composita* sp. (R).
- Wayne Township:
- MUwy-1. Abandoned Henry Young Mine, NE¼ sec. 14, ZANESVILLE EAST. Columbiana (1). OGS 472. *Eolissochonetes fragilis* (R), *Mesolobus mesolobus* (R), *M. obsoletus* (A), *Antiquatonia portlockiana?* (R), *Composita* sp. (A).
- NOBLE COUNTY:
- Olive Township:
- No-2. Exposures along relocated Rte. 21 (Interstate 77), SW¼ sec. 11, CALDWELL SOUTH.

- Ames (1). OGS 15055. *Neochonetes semiacanthus* (C), *Juresania nebrascensis* (R), *Linoproductus* sp. (R), *Neospirifer dunbari*? (R).
- No-3. Exposures along old Rte. 21, 1.5 mi. north of Dudley (probably NE $\frac{1}{4}$ sec. 15), CALDWELL SOUTH. Ames (1). *Neochonetes semiacanthus* (A), *Antiquatonia portlockiana crasscostata* (R), *Linoproductus* sp. (R).
- PERRY COUNTY:**
- Bearfield Township:**
- Pb-1. Abandoned Wabash RR. tunnel cut (railroad never built), (type locality for Portersville), N $\frac{1}{2}$ SW $\frac{1}{4}$ sec. 24, DEAVERTOWN. Portersville (3). OGS 10375. *Crania modesta* (R), *Derbyia* cf. *D. plattsmouthensis* (R), *Chonetinella alata* (A), *Linoproductus* sp. (R), *Neospirifer latus*? (R).
- Clayton Township:**
- Pcl-1. Abandoned strip mine, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5, FULTONHAM. Columbiana or Vanport(?), Upper Mercer (1). OGS 8583. *Lingula carbonaria* (A), *Orbiculoidea missouriensis* (C), *O. capuliformis* (C), *Derbyia crassa* (C), *Mesolobus striatus* (A), *Echinaria semipunctata knighti* (A), *Juresania nebrascensis* (A), *Antiquatonia portlockiana* (A), *A. p. quadrata* (R), *Reticulatia rugata*? (R), *Linoproductus* sp. (A), *Composita subtilita*? (A), *C. ovata*? (A), *Neospirifer goreii*? (R), *Phricodothyris perplexa* (A), *Beecheria bovidens*? (R).
- Coal Township:**
- Pco-1. Exposure in ravine on northwest side of Rte. 216, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, NEW STRAITSVILLE. Dorr Run (1). *Lingula carbonaria* (R).
- Harrison Township:**
- Pha-1. Exposure along ravine south of Porter Run and west of Rte. 93 (formerly Rte. 75), NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 4, CROOKSVILLE. Upper Mercer (1). *Mesolobus striatus* (R), *Kozlowskia haydenensis* (A), *Composita subtilita*? (R), *C. ovata* (C), *Anthracospirifer opimus*? (R), *A. occiduus* (C), *Neospirifer cameratus*? (C).
- Pha-2. Undescribed and uncertain exposure, SE $\frac{1}{4}$ sec. 19, CROOKSVILLE. Undifferentiated Brush Creek (1). OGS 8509? *Juresania nebrascensis* (R), *Antiquatonia* sp. (R), *Linoproductus* sp. (C).
- Pha-3. Exposure along east-west road between abandoned strip mines and road junction at elev. no. 985, SW $\frac{1}{4}$ sec. 33, DEAVERTOWN. Upper Freeport (2). OGS 8510. *Lingula carbonaria* (R), *Orbiculoidea missouriensis* (C).
- Hopewell Township:**
- Pho-1. Exposures along road, approx. 2.0 mi. northwest of Somerset, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, SOMERSET. Upper Mercer (1). *Kozlowskia haydenensis* (A), *Linoproductus planiventralis* (C), *Anthracospirifer opimus* (R), *Neospirifer* sp. (R), *Phricodothyris perplexa* (R).
- Jackson Township:**
- Pj-1. Junction City Clay Co. shale pit, east of north-south road, SE $\frac{1}{4}$ sec. 3, Junction City, JUNCTION CITY. Lower Mercer (2). OGS 8376. *Derbyia* sp. (R), *Mesolobus striatus* (R), *Kozlowskia haydenensis* (R), *Juresania nebrascensis inflata* (R), *Antiquatonia portlockiana*? (R), *A. p. quadrata*? (C), *Linoproductus planiventralis* (C), *Composita subtilita* (R), *Anthracospirifer occiduus* (C).
- Pj-2. Undescribed and uncertain exposure, sec. 23, JUNCTION CITY. Vanport (1). *Juresania* sp. (R).
- Pj-3. Strip pit on Starner farm, NE $\frac{1}{4}$ sec. 24, JUNCTION CITY. Columbiana (1). *Derbyia* cf. *D. subcircularis* (R), *Juresania nebrascensis* (C), *Reticulatia rugata* (R), *Neospirifer cameratus* (C).
- Pj-4. Rush Creek Clay Co. strip pit, SW $\frac{1}{4}$ sec. 3, JUNCTION CITY. Lower Mercer (1). OGS 8375. *Composita ovata*? (R).
- Monday Creek Township:**
- Pmc-1. Exposure along ravine, southeast of north-east-extending road, ctr. sec. 9, JUNCTION CITY. Lower Mercer (1). OGS 12800. *Derbyia crassa* (R), *Mesolobus striatus* (R), *Kozlowskia haydenensis* (A), *Desmoinesia muricata*? (R), *Juresania nebrascensis inflata* (R), *J. sp.* (R), *Antiquatonia portlockiana quadrata* (C), *A. sp.* (R), *Composita* sp. (R), *Crurithyris planoconvexa* (R), *Anthracospirifer rockymontanus* (R), *A. occiduus* (R).
- Pmc-2. Exposure along ravine west of road junction at elev. no. 817, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 17, GORE. Lower Mercer (1). OGS 8325. *Mesolobus striatus* (R), *Composita subtilita*? (C), *Anthracospirifer occiduus* (A), *Phricodothyris perplexa* (R).
- Pmc-3. Exposure along ravine or road, SE $\frac{1}{4}$ sec. 19, GORE. Upper Mercer (1). *Mesolobus striatus* (R), *Composita* sp. (R), *Anthracospirifer occiduus* (C), *Neospirifer goreii* (R).
- Monroe Township:**
- Pmo-1. Exposure along road(?), NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, CORNING. Cambridge (1). OGS 8687. *Chonetinella flemingi* (C).
- Pmo-2. Undescribed and uncertain exposure, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, DEAVERTOWN. Portersville (1). OGS 8535. *Chonetinella alata* (A), *C. verneuliana* var. (R).
- Pmo-3. Exposure along road in Wildcat Hollow, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 13, CORNING. Portersville (1). *Chonetinella alata* (A).
- Pmo-4. Exposure on fruit farm, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 21, CORNING. Portersville (2). *Chonetinella alata* (A), *Antiquatonia portlockiana* (R).
- Pmo-5. Exposure along west side of road at road junction at elev. no. 993, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, CORNING. Ames (1). OGS 8544. *Neochonetes semiacanthus* (R), *Crurithyris planoconvexa* (R).
- Pike Township:**
- Pp-1. Ludowic-Celadon Co. shale pit, NW $\frac{1}{4}$ sec. 7, NEW LEXINGTON. Columbiana, Putnam Hill, and Upper Mercer (1). OGS 5357. *Neospirifer cameratus* (R).
- Pleasant Township:**
- Ppl-1. Undescribed and uncertain exposure (possibly

strip mine), sec. 24, NEW LEXINGTON. Washingtonville (1). *Lingula carbonaria* (C), *Linoproductus* sp. (R).

Reading Township:

- Pr-1. Undescribed and uncertain exposure on Mooter farm south of Somerset, sec. 22, SOMERSET. Lower Mercer (1). See OGS 8401. *Orbiculoidea* sp. (R), ?*Rugosochonetes delicatus* (R), *Mesolobus striatus* (R), *Anthracospirifer occiduus*? (R), *Neospirifer goreii* (R).
- Pr-2. Exposure along road, 0.5 mi. south of St. Joseph's Priory, ctr. sec. 23, SOMERSET. Lower Mercer (1). OGS 8350. *Orbiculoidea missouriensis* (R), *Derbyia* sp. (C), *Mesolobus striatus* (C), *chonetid* indetermin. (R), *Kozlowskia haydenensis* (C), *Juresania nebrascensis inflata* (C), *Antiquatonia portlockiana quadrata* (A), *Linoproductus* sp. (C), *Cleiothyridina orbicularis* (R), *Composita* sp. (C), *Anthracospirifer* sp. (A), *Phricodothyris perplexa* (R).
- Pr-3. Exposures in B & O RR. cut at Somerset, NW $\frac{1}{4}$ sec. 10, SOMERSET. Lower Mercer (1). OGS 8427. *Kozlowskia haydenensis* (C), *Juresania* sp. (R), *Antiquatonia portlockiana quadrata* (C), *Composita subtilita*? (R), *Anthracospirifer rockymontanus* (R), *Neospirifer cameratus* (R).
- Pr-4. Exposure at pond on Swern farm, east edge, sec. 22, SOMERSET. Lower Mercer (1). *Linoproductus* sp. (R).
- Pr-5. Exposure in road cut, NW $\frac{1}{4}$ (?) sec. 22, SOMERSET. Lower Mercer (1). *Juresania nebrascensis* (R).
- Pr-6. Exposure in stream channel west of north-south road, SW $\frac{1}{4}$ (?) sec. 34, JUNCTION CITY. Lower Mercer (1). OGS 8421. *Antiquatonia portlockiana quadrata* (R), *Composita ovata*? (R), *Anthracospirifer occiduus* (R).

Salt Lick Township:

- Psl-1. Exposure in ravine, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5, NEW LEXINGTON. Putnam Hill (1). OGS 8297. *Composita* sp. (R).

PORTAGE COUNTY:

Atwater Township:

- POa-1. Strip mines in vicinity of junction of Rtes. 224 and 225, approx. 2.3 mi. west of Deerfield and 2.2 mi. south of Yale, DEERFIELD. Lower Mercer (4). *Orbiculoidea* sp. (R), *Rugosochonetes delicatus* (C), *Mesolobus striatus* (A), *M. obsoletus* (A), *Kozlowskia haydenensis* (C), *Desmoinesia* sp. (R), *Juresania nebrascensis*? (R), *J. n. inflata* (R), *Antiquatonia portlockiana quadrata* (R), *Composita* sp. (R), *Anthracospirifer rockymontanus*? (A), *Neospirifer goreii*? (C), *Punctospirifer kentuckyensis* (A).

Deerfield Township:

- POd-1. Combined with POa-1 (which see).

SCIOTO COUNTY:

Vernon Township:

- Scve-1. Exposure approx. 4.0 mi. southeast of Lyra on east side of Clinton Furnace Rd. and ap-

prox. 100 ft. above base of hill on land of Edward Toffins in extreme southeast corner of Vernon Tp. (Morningstar's locality 31), PEDRO. Lower Mercer (1). OGS 4246, 4645. *Isogramma millepunctata* (R).

STARK COUNTY:

Bethlehem Township:

- Sb-1. Undescribed and uncertain exposure, sec. 29, NAVARRE. Lower Mercer (1). *Derbyia* sp. (R), *Antiquatonia portlockiana quadrata* (R), *Composita subtilita* (R), *Anthracospirifer rockymontanus*? (R), *A. occiduus* (R), *Punctospirifer kentuckyensis* (R).

Canton Township:

- Sc-1. Undescribed and uncertain exposures in vicinity of Waco, CANTON EAST. Putnam Hill (1). See OGS 13492. *Mesolobus striatus* (R), *Reticulatia rugata*? (R), *Composita subtilita* (C), *Phricodothyris perplexa* (R).

Lexington Township:

- Sle-19. Rock fragments from post holes along west side of Rockhill Ave. at Rossland St., SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 23, ALLIANCE. Undifferentiated Allegheny (probably Columbiana or Vanport) (1). *Chonetinella* sp. (R), *Mesolobus obsoletus*? (R), *Desmoinesia muricata* (R).
- Sle-25. Exposure along stream on Raymond Hoover farm, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, LIMAVILLE. Putnam Hill (1). OGS 6887. *Mesolobus* sp. (R), *Composita* sp. (C), *Phricodothyris perplexa* (C).
- Sle-28. Exposure along east side of small stream on W. A. Smyth farm, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 22, LIMAVILLE. Putnam Hill (1). OGS 6890. *Derbyia* sp. (R), *Mesolobus striatus* (R), *Composita* sp. (C), *Phricodothyris perplexa* (C).

Marlboro Township:

- Sm-1. Abandoned Clapsaddle quarry, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 24, LIMAVILLE. Putnam Hill (1). OGS 6891. *Antiquatonia portlockiana quadrata* (R), *Composita argentea* (A), *Phricodothyris perplexa* (A), *Beecheria bovidens*? (R).
- Sm-2. Diamond Portland Cement Co. quarry, S $\frac{1}{2}$ SW $\frac{1}{4}$ sec. 32, HARTVILLE. Putnam Hill (2). OGS 12825. *Composita* sp. (R), *Phricodothyris perplexa* (R).

Osnaburg Township:

- So-1. Undescribed and uncertain exposure, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, MALVERN. Washingtonville (1). *Mesolobus mesolobus* (R), *Desmoinesia muricata* (R), *Juresania nebrascensis* (R).

Pike Township:

- Spk-1. Abandoned strip mine, north side Gracemont St., NW $\frac{1}{4}$ sec. 30, BOLIVAR. Putnam Hill, Tuscarawas, and Vanport (2). OGS 13503. *Derbyia* sp. (A), *Eolissochonetes fragilis* (A), *Mesolobus striatus* (R), *Chonetinella crassiradiata*? (R), *Antiquatonia portlockiana quadrata* (R), *Cleiothyridina orbicularis* (R), *Composita argentea* (A), *C. elongata* (R), *C. girtyi* (C), *Anthracospirifer rockymontanus* (C), *Neospirifer cameratus* (C), *Phricodothyris perplexa* (A).

- Spk-2. Exposure in small valley on south side Westbrook St., NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, WAYNESBURG. Putnam Hill (1). *Composita* sp. (C), *Phricodothyris perplexa* (C).

Sandy Township:

- Ss-1. Abandoned strip mine, NE $\frac{1}{4}$ sec. 4, WAYNESBURG. Columbiana (1). OGS 14651. *Mesolobus mesolobus* (R), *Desmoinesia muricatina* (R), *Juresania nebrascensis* (C), *Linoproductus echinatus?* (C).
- Ss-2. Undescribed and uncertain exposure, N ctr. sec. 28, WAYNESBURG. Columbiana (1). *Juresania nebrascensis* (R), *Linoproductus* sp. (R), *Composita ovata?* (R), *Neospirifer* sp. (R).

SUMMIT COUNTY:

Green Township:

- Sug-1. Natco strip pit, southeast of junction of Aultman and Highland Park Rds., SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 36, NORTH CANTON. Lower Mercer (1). OGS 15122. *Kozlowskia haydenensis* (C), *Linoproductus* sp. (C), *Composita* sp. (C), *Neospirifer goreii?* (C).

Springfield Township:

- SUsf-1. Robinson Clay Products Co. (formerly Camp Clay Co.) shale pit, north of Mogadore, AKRON EAST. Undifferentiated Pottsville (1). OGS 11420. *Lingula carbonaria* (A), *Anthracospirifer* sp. (R).

TUSCARAWAS COUNTY:

Dover Township:

- Td-1. Abandoned strip mines, north of Rte. 16 and east of Rte. 8 and Tuscarawas R., DOVER. Columbiana and Washingtonville (1). *Mesolobus lioderma?* (R), *Desmoinesia muricatina* (C), *Echinaria* sp. (R), *Juresania* sp. (R), *Antiquatonia portlockiana* (C), *Linoproductus* sp. (R), *Composita subtilita* (R), *C. ovata?* (R), *C. sp.* (R), *Phricodothyris perplexa* (R).

Franklin Township:

- Tfr-1. Exposure, south side of Sugar Cr. just below Beach City Dam, W ctr. sec. 1?, NAVARRE. Boggs (4). OGS 13327. *Rhipidomella carbonaria* (R), *Derbyia crassa* (C), *D. sp.* (C), *Rugosochonetes delicatus* (A), *Mesolobus obsoletus* (C), *Desmoinesia muricatina* (A), *Antiquatonia portlockiana quadratia* (C), *A. costellata* (C), *Linoproductus planiventralis?* (R), *L. sp.* (C), *Hustedia miseri?* (C), *Composita subtilita* (C), *Anthracospirifer rocky-montanus* (C), *A. occiduus* (A).

Jefferson Township:

- Tj-1. Stone Creek Brick Co. shale pit just north of plant and east of Stone Cr. and Pennsylvania RR., NW $\frac{1}{4}$ sec. 12, STONE CREEK. Putnam Hill (1). OGS 5492. *Mesolobus obsoletus* (A), *Desmoinesia muricatina* (A), *Wellerella tetrahedra?* (C), *Cleiothyridina orbicularis* (C), *Hustedia mormoni?* (R), *Composita subtilita?* (A), *Neospirifer cameratus?* (C).

Lawrence Township:

- TI-1. Bolivar Clay Products Co. abandoned shale

pit, west side of N & W RR. and in west edge of Bolivar, BOLIVAR. Putnam Hill (1). OGS 1914, 4996. *Antiquatonia* sp. (R), *Phricodothyris perplexa* (R).

TI-2.

Abandoned strip mine, 0.5 mi. north of road junction at elev. no. 977, approx. 1.1 mi. east-northeast of Strasburg, NW $\frac{1}{4}$ sec. 16, STRASBURG. Putnam Hill (1). *Derbyia* sp. (R), *Mesolobus obsoletus* (C), *Desmoinesia muricatina* (A), *Hustedia mormoni* (C), *Composita* sp. (R), *Anthracospirifer* sp. (R).

TI-4.

Abandoned strip mine, approx. 0.5 mi. north of Zoar between township road 57 and county road 82, DOVER. Putnam Hill (1). OGS 13364. *Chonetinella crassiradiata* (R), *Desmoinesia muricatina* (R), *Reticulatia rugatia?* (R), *Composita subtilita?* (C), *Anthracospirifer* sp. (R), *Neospirifer* sp. (A), *Phricodothyris perplexa* (R).

Sandy Township:

Ts-1.

Abandoned borrow pit, northwest side Rte. 8 and Pennsylvania RR., approx. 1.0 mi. southwest Mineral City and 0.7 mi. northeast of Valley Junction, DOVER. Putnam Hill and Vanport (1). *Mesolobus striatus* (R), *Antiquatonia portlockiana quadratia* (C), *Composita subtilita* (R), *Phricodothyris perplexa* (C).

Ts-2.

Exposure in B & O RR. cut, approx. 0.75 mi. northwest of Mineral City, MINERAL CITY. Dorr Run (1). OGS 11344. *Lingula carbonaria?* (R).

Ts-3.

Exposure along Rte. 183 (formerly Rte. 80), approx. 1.75 mi. east of Nimishillen Cr. and southwest of Farber Cem., WAYNESBURG. Columbiana (1). ?*Orbiculoidea missouriensis* (R).

Sugar Creek Township:

Tsc-1.

Belden Brick (formerly Finzer Bros.?) Co. strip mine, northeast of Shanesville, NW $\frac{1}{4}$ sec. 2 and NE $\frac{1}{4}$ sec. 3, SUGARCREEK. Putnam Hill and Vanport (2). OGS 13316. *Orbiculoidea missouriensis* (R), *Derbyia crassa* (A), *D. cf. D. subcircularis?* (R), *Mesolobus striatus?* (R), *M. obsoletus* (A), *Desmoinesia muricatina* (R), *Antiquatonia portlockiana?* (R), *A. p. quadratia* (C), *Wellerella tetrahedra* (R), *Composita subtilita?* (R), *Crurithyris planoconvexa* (R), *Neospirifer cameratus?* (R).

Tsc-2.

Clay strip mine at Sugarcreek, W ctr. sec. 1, SUGARCREEK. Putnam Hill (1). OGS 5178. *Orbiculoidea* sp. (R), *Mesolobus striatus* (C), *M. obsoletus* (A), *Desmoinesia muricatina* (A), *Hustedia mormoni* (R), *Composita* sp. (R).

Warwick Township:

Twa-1.

Abandoned strip mines, southwest side of Fox Valley extending northwest into Clay Tp., SW $\frac{1}{4}$ sec. 4, NEW PHILADELPHIA. Columbiana and Washingtonville (2). *Derbyia cf. D. subcircularis* (R), *Desmoinesia muricatina* (A), *Echinaria* sp. (R), *Antiquatonia* sp. (R), *Linoproductus* sp. (R), *Composita subtilita* (R), *C. sp.* (R), *Neospirifer latus?* (or *cameratus*) (R).

Wayne Township:

- Twy-2. Abandoned strip mines approx. 2.65 mi. south of junction of Holmes, Stark, and Tuscarawas Counties and east of road junction at elev. no. 1300, WILMOT. Upper Mercer (1). *Derbyia crassa?* (R), *Mesolobus striatus* (R), *Desmoinesia muricata* (R), *Antiquatonia portlockiana quadrata* (C), *A. sp.* (R), *Linopproductus sp.* (R), *Composita ovata* (R), *Anthracospirifer occiduus* (A), *Neospirifer cameratus* (C), *N. goreii?* (R), *Punctospirifer kentuckyensis* (R).

York Township:

- Ty-1. Howe Coal Co. strip mine, south of county road 55, NW¼ sec. 24, NEW PHILADELPHIA. Washingtonville (1). *Eolissochonetes fragilis* (R), *Mesolobus mesolobus* (R), *Juresania nebrascensis* (R), *Antiquatonia portlockiana* (C), *Linopproductus sp.* (R), *Composita ovata?* (R), *Neospirifer sp.* (R).
- Ty-2. Abandoned strip mine approx. 0.75 mi. west of Rte. 21 and 0.5 mi. northwest of Blackband, STONE CREEK. Washingtonville (1). *Derbyia sp.* (R), *Mesolobus mesolobus* (A), *Desmoinesia muricata* (A), *Antiquatonia portlockiana* (A), *Linopproductus sp.* (A), *Cleiothyridina orbicularis* (R), *Composita sp.* (A), *Crurithyris planoconvexa* (C).

VINTON COUNTY:

Brown Township:

- Vb-1. Exposures along Rte. 328, SW¼ sec. 36, NEW PLYMOUTH. Boggs (1). OGS 1588. *Orbiculoidea capuliformis?* (A), *Derbyia sp.* (A), *Juresania sp.* (R), *Composita sp.* (R), *Anthracospirifer rockymontanus?* (C), *A. occiduus* (C).
- Vb-2. Undescribed and uncertain exposure along road (probably Rte. 278), sec. 9 or 10, MINERAL. Undifferentiated Allegheny (1). *Orbiculoidea capuliformis?* (R).

Clinton Township:

- Vc-6. Exposures along tributary valley to Sugar Run, NW¼ sec. 27, MCARTHUR. Vanport (3). OGS 5388. *Hustedia mormoni* (R), *Composita argentea* (R), *C. sp.* (R), *Phricodothyris perplexa* (A), *Beecheria bovidens* (A).

Elk Township:

- Vel-6. Exposures along road, N ctr. sec. 17, ALLENSVILLE and ZALESKI. Lower Mercer (4). OGS 153. *Orbiculoidea missouriensis* (R), *Schizophoria resupinoides?* (R), *Rhipidomella carbonaria* (R), *Derbyia crassa* (R), *Rugosochonetes delicatus* (A), *Plicochonetes dotus* (A), *Krotovia paucispina* (R), *Desmoinesia muricata missouriensis* (A), *Echinaria sp.* (R), *Juresania nebrascensis* (R), *J. sp.* (C), *Antiquatonia costellata* (A), *Linopproductus planiventralis* (C), *L. echinatus?* (R), *L. sp.* (R), *Hustedia miseri* (R), *Cleiothyridina orbicularis* (C), *Composita subtilita?* (A), *C. ovata?* (C), *Anthracospirifer rockymontanus?* (C), *A. occiduus* (A), *Punctospirifer kentuckyensis* (A).
- Vel-7. Exposure at tippie of Vinton Coal Co., north

side Rte. 50, SW¼NE¼ sec. 18, ALLENSVILLE. Lower Mercer (1). See OGS 153. *Derbyia crassa* (C), *Rugosochonetes delicatus* (A), *Plicochonetes dotus* (C), *Krotovia paucispina* (R), *Desmoinesia muricata* (R), *D. m. missouriensis* (A), *Antiquatonia costellata* (A), *Cleiothyridina orbicularis* (R), *Composita subtilita* (A), *C. sp.* (C), *Anthracospirifer occiduus* (A), *Punctospirifer kentuckyensis* (R).

- Vel-8. Exposure on southeast side of ravine, north side east-west road, SW¼NW¼ sec. 33, MCARTHUR. Lower Mercer (2). OGS 13276. *Orbiculoidea sp.* (R), *Rugosochonetes delicatus* (R), *Mesolobus striatus* (C), *Kozlowskia haydenensis* (C), *Antiquatonia portlockiana quadrata* (R), *Crurithyris planoconvexa* (R), *Anthracospirifer rockymontanus?* (R), *A. occiduus* (C).

- Vel-9. Abandoned strip mine, SE¼ sec. 3, ZALESKI. Putnam Hill (1). *Mesolobus striatus* (A), *Kozlowskia haydenensis* (A), *Composita sp.* (R), *Anthracospirifer occiduus* (R).

- Vel-10. Abandoned strip mine, NW¼ sec. 11, ZALESKI. Putnam Hill (3). *Derbyia crassa* (A), *Mesolobus striatus* (A), *Kozlowskia haydenensis* (C), *Desmoinesia muricata* (R), *Antiquatonia portlockiana quadrata* (R), *A. sp.* (R), *Reticulatia rugata* (R), *Linopproductus planiventralis?* (R), *L. sp.* (R), *Composita subtilita?* (C), *C. ovata* (R), *Anthracospirifer occiduus* (C).

- Vel-11. Abandoned strip mine, south side abandoned road N¼NE¼ sec. 17, ZALESKI. Putnam Hill (2). OGS 1438. *Crania modesta* (R), *Derbyia crassa* (A), *Mesolobus striatus* (A), *Kozlowskia haydenensis* (A), *Desmoinesia muricata?* (R), *Juresania sp.* (R), *Antiquatonia portlockiana quadrata* (A), *Composita subtilita?* (C), *Anthracospirifer occiduus* (A).

- Vel-12. Vinton Coal Co. abandoned strip mine on northeast side of road 1.1 mi. north-northwest of road junction at elev. no. 799, ctr. sec. 20 and NW¼ sec. 17, ALLENSVILLE and ZALESKI. Putnam Hill (2). OGS 238. *Mesolobus striatus* (A), *Kozlowskia haydenensis* (A), *Desmoinesia muricata* (R), *D. m. missouriensis?* (R), *Reticulatia rugata* (C), *Linopproductus sp.* (R), *Composita sp.* (C), *Anthracospirifer occiduus* (A).

- Vel-13. Uncertain exposure, probably small abandoned mine on property formerly owned by Wm. Jacobs, NE¼ sec. 25, MCARTHUR. Putnam Hill (1). OGS 142. *Derbyia sp.* (C), *Mesolobus striatus* (R), *Kozlowskia haydenensis?* (R), *Composita subtilita?* (A), *Anthracospirifer occiduus* (A).

- Vel-14. Abandoned borrow pit, west of deep road cut and north of Rte. 50, NE¼ sec. 25, MCARTHUR. Putnam Hill (2). See OGS 142. *Lingula carbonaria?* (R), *Orbiculoidea sp.* (R), *Derbyia sp.* (C), *Mesolobus striatus* (A), *Kozlowskia haydenensis* (R), *Desmoinesia muricata* (R), *Anthracospirifer opimus?* (A), *Phricodothyris perplexa* (A).

- Vel-15. Abandoned J. A. Crow (on former Truman Dixon property), strip mine, south side Rte. 50, NW¼ sec. 27, MCARTHUR. Putnam Hill

- (4). OGS 11819. *Orbiculoidea capuliformis*? (R), *Derbyia crassa* (C), *D. sp.* (C), *Mesolobus striatus* (A), *Juresania nebrascensis* (R), *Linoproductus planiventralis* (R), *L. sp.* (C), *Cancrinella sp.* (R), *Composita sp.* (A), *Phricodothyris perplexa* (A).
- Vel-16. Exposure along road (type locality for Zaleski), SW $\frac{1}{4}$ sec. 12, ZALESKI. Zaleski (1). OGS 60. *Derbyia crassa*? (C), *Mesolobus striatus*? (R), *Antiquatonia sp.* (R), *Anthracospirifer rockymontanus*? (R), *Phricodothyris perplexa* (R).
- Vel-17. Exposure on Miles Ogan farm, SE $\frac{1}{4}$ sec. 14, ZALESKI. Zaleski (1). OGS 64. *Derbyia sp.* (C), chonetid indetermin. (R), *Kozlowskia haydenensis* (R), *Desmoinesia muricatina* (C), *D. sp.* (R), *Juresania nebrascensis* (A), *Antiquatonia portlockiana*? (C), *Composita sp.* (R), *Anthracospirifer opimus*? (R), *A. occidentus*? (C).
- Vel-18. Undescribed and uncertain locality or localities, ZALESKI? Zaleski (1). *Derbyia crassa*? (C), *Mesolobus striatus* (C), *Juresania sp.* (R), *Linoproductus sp.* (R), *Composita sp.* (C), *Anthracospirifer opimus*? (C).
- Vel-19. Vinton Coal Co. abandoned strip mine, SE $\frac{1}{4}$ sec. 7, ALLENSVILLE. Vanport (1). *Mesolobus mesolobus* (A), *M. striatus* (A), *Kozlowskia haydenensis* (A), *Antiquatonia portlockiana quadratia* (R), *Composita sp.* (R), *Anthracospirifer occidentus* (C), *Phricodothyris perplexa* (A).
- Vel-20. Abandoned strip mines, E ctr. and NE $\frac{1}{4}$ sec. 15, ZALESKI. Vanport (3). *Derbyia sp.* (R), *Mesolobus striatus* (A), *Juresania sp.* (R), *Reticulatia rugatia* (C), *Linoproductus pratensis* (R), *L. sp.* (R), *Anthracospirifer occidentus*? (C).
- Vel-21. McArthur Stone Co. quarry, SW $\frac{1}{4}$ sec. 25, MCARTHUR. Vanport (1). OGS 75. *Orbiculoidea missouriensis* (R), *Mesolobus striatus* (R), *Reticulatia rugatia*? (R), *Composita sp.* (R).
- Vel-22. Abandoned strip mine, SW $\frac{1}{4}$ sec. 26, MCARTHUR. Vanport (1). *Mesolobus striatus* (C).
- Vel-23. Abandoned strip mine, SW $\frac{1}{4}$ sec. 23 and NW $\frac{1}{4}$ sec. 26, MCARTHUR. Vanport (1). OGS 78, 79. *Derbyia sp.* (R), *Antiquatonia portlockiana*? (R), *Composita sp.* (R).
- Madison Township:
Vm-1. Exposure in deep road cut along Rte. 50, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 32, MCARTHUR. Vanport(?) and Zaleski (1). OGS 15066. *Lingula carbonaria* (R), *Orbiculoidea missouriensis*? (C).
- Vm-5. Vm-1 (which see).
- Richland Township:
Vr-1. Exposure on north side of road, SE $\frac{1}{4}$ sec. 13, HAMDEN. Lower Mercer (2). OGS 215. *Lingula carbonaria* (R), *Orbiculoidea missouriensis* (R), *Derbyia crassa*? (C), *Rugosochonetes delicatus* (A), *Plicochonetes dotus* (R), *Desmoinesia muricatina missouriensis* (C), *Antiquatonia portlockiana quadratia* (R), *A. costellata* (A), *Linoproductus planiventralis* (C), *Composita subtilita* (C), *Anthracospirifer occidentus* (A), *Punctospirifer kentuckyensis* (R).
- Vr-2. Abandoned strip mines on opposite sides of Rte. 50, W $\frac{1}{2}$ sec. 1, ALLENSVILLE. Vanport (1). OGS 187. *Composita sp.* (A).
- Swan Township:
Vs-1. Central States Coal Co. abandoned strip mine, approx. 0.5 mi. south of Orland, NW $\frac{1}{4}$ sec. 12, ZALESKI. Vanport (2). OGS 6919. *Lingula carbonaria* (R), *Trigonoglossa kentuckyensis*? (R), *Orbiculoidea capuliformis* (A), *Derbyia sp.* (R).
- Vs-3. Central States Coal Co. abandoned strip mine on Merz farm, ctr. sec. 10, ZALESKI. Vanport (2). OGS 1560. *Orbiculoidea capuliformis* (R), *Derbyia crassa* (A), *Mesolobus mesolobus* (A), *M. striatus* (A), *M. decipiens* (A), *Reticulatia rugatia* (A), *Linoproductus echinatus*? (R), *Cleiothyridina orbicularis* (R), *Composita subtilita*? (A), *C. argentea* (A), *Anthracospirifer sp.* (R), *Phricodothyris perplexa* (R).
- Vs-4. Undescribed and uncertain exposure, NE $\frac{1}{4}$ sec. 27, ZALESKI. Vanport (1). See OGS 6923. *Lingula carbonaria* (A).
- Wilkesville Township:
Vw-1. Undescribed exposure, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, MULGA. Vanport (1). See OGS 1412. *Phricodothyris perplexa* (R), *Beecheria bovidens* (R).
- WAYNE COUNTY:-
Paint Township:
WApa-1. Mullet Coal Co. quarry, SW $\frac{1}{4}$ sec. 13, WILMOT. Putnam Hill (1). OGS 12162. *Kozlowskia haydenensis* (R), *Juresania sp.* (R), *Linoproductus sp.* (R), *Neospirifer cameratus* (R), *Phricodothyris perplexa* (R).
- WApa-2. Uncertain exposure along Rte. 250, sec. 24, WILMOT. Putnam Hill or Upper Mercer (1). See OGS 10069A. *Derbyia sp.* (A).

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PLATES
1 THROUGH 22

PLATE 1

FIGURES 1-3. *Lingula carbonaria* Shumard.

1. Pedicle? view, X2; Columbiana limestone and shale, Mg-2; OSU-27028.
2. Brachial? view, X2; Dorr Run shale, Ay-62; OSU-27029.
3. Pedicle? interior view, X4; Putnam Hill limestone and shale, Mg-5; OSU-27030.
4. *Lingula lemniscata*? Price. Brachial view, X2; Putnam Hill limestone and shale, Mc-2; OSU-27031.
- 5, 6. *Trigonoglossa nebrascensis* (Meek).
 5. Pedicle view, X1; Columbiana limestone and shale, Mg-6; OSU-27032.
 6. Squeeze of pedicle valve, X1; Lower Mercer limestone and shale, MUC-1; OSU-15218.
- 7-11. *Orbiculoidea missouriensis* (Shumard).
 7. Brachial view, X3; Columbiana limestone and shale, Cp-5; OSU-27033.
 8. Pedicle interior view, X2; Putnam Hill limestone and shale, Tsc-1; OSU-27034.
 9. Brachial view, X2; Vanport limestone and shale, Vel-21; OSU-27043.
 - 10, 11. Lateral and brachial views of internal mold, X2; Brush Creek limestone and shale, Aa-41; OSU-27035.
- 12-15. *Orbiculoidea capuliformis* (McChesney).
 - 12, 13. Lateral and brachial views of internal mold, X1; Lower Brush Creek limestone and shale, Ale-33; OSU-27036.
 14. Pedicle interior view, X1; Vanport limestone and shale, Pcl-1; OSU-27038.
 15. Pedicle interior view, X1; Vanport limestone and shale, Vs-1; OSU-27037.
- 16-19. *Orbiculoidea meekana*? (Whitfield).
 - 16, 17. Brachial and lateral views of internal mold, X1; Quakertown shale, Mco-1; OSU-27039.
 - 18, 19. Brachial internal mold and pedicle interior views, X1; Lower Mercer limestone and shale, Huc-1; OSU-9794.
20. *Lindstroemella patula* (Girty). Brachial internal mold, X4; Washingtonville shale, MUmu-1; OSU-27040.
- 21-25. *?Oehlertella stoutella* (Morningstar). Brachial, lateral, brachial, lateral, and brachial views of internal molds, X1; Harrison ironstone, Jh-1; OSU-15219, 15220, 27041, 27042.
- 26, 27. *Crania modesta* White & St. John. Two pedicle interiors, attached to pelecypod shells, X2; Lower Mercer limestone and shale, Hfg-5; OSU-27044, 27045.

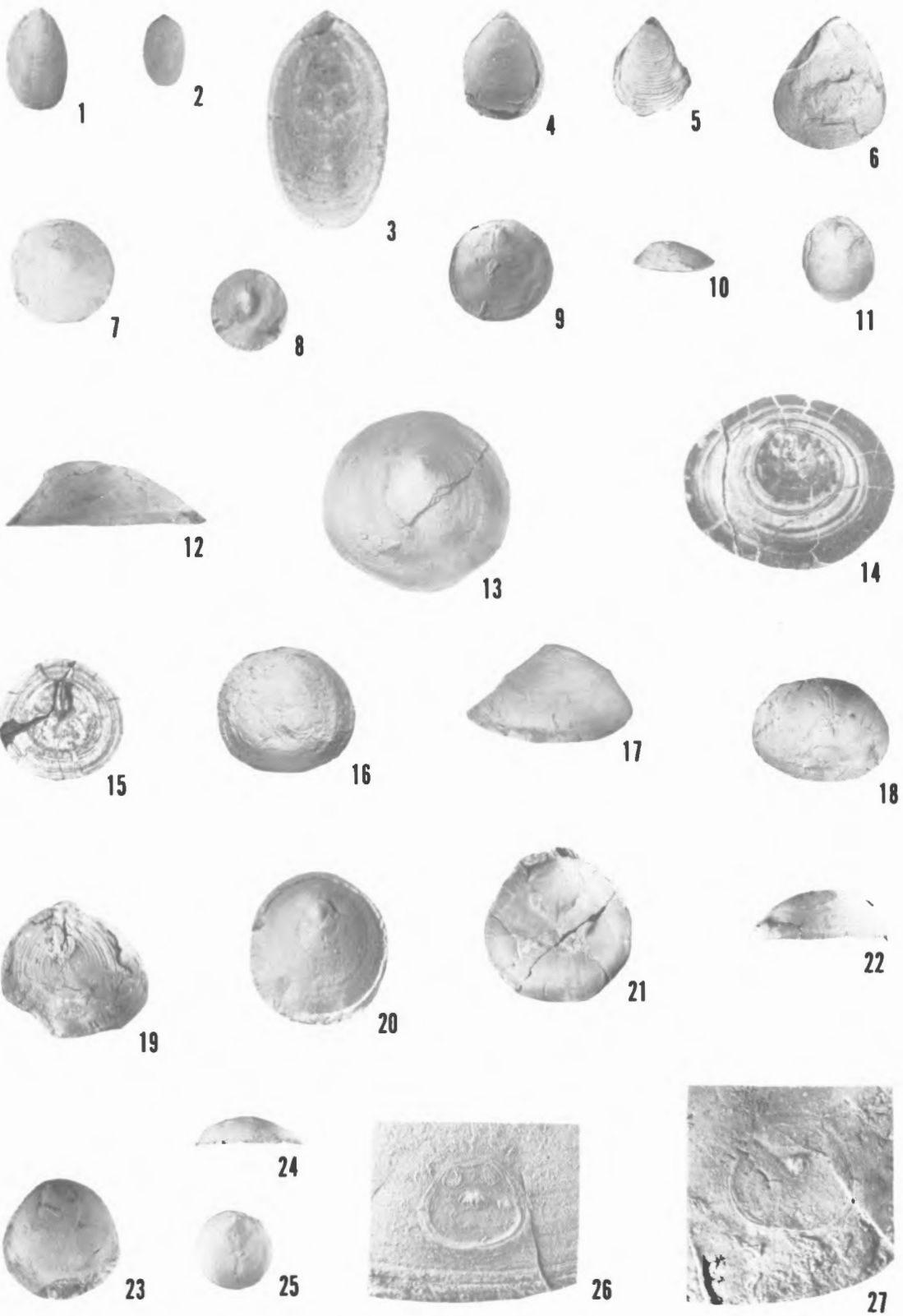


PLATE 2

(All figures X1 except where noted)

FIGURES 1-3. *Meekella striatocostata* (Cox).

1, 2. Pedicle and brachial views; Cambridge limestone and shale, Gwe-1; OSU-27046, 27047.

3. Fragment of pedicle interior, X2; Cambridge limestone and shale, Gwe-1; OSU-27048.

4-6. *Enteleles hemiplicatus* (Hall). Brachial, lateral, and anterior views; Ames limestone and shale, CAc-2; OSU-27049.

7-12. *Schizophoria resupinoides?* (Cox).

7-11. Pedicle internal mold, brachial internal mold, squeeze of brachial mold, squeeze of pedicle valve, and squeeze of brachial external mold, X2; Upper Mercer limestone and shale, Cs-13; OSU-27051.

12. Pedicle view of crushed specimen; Lower Mercer limestone and shale, Vel-6; OSU-27050.

13, 14. *Rhipidomella carbonaria* (Swallow). Brachial and lateral views, X2; Ames limestone and shale, JEwa-1; OSU-27052.

15, 16. *Isogramma millepunctata* (Meek & Worthen).

15. External mold; Lower Mercer limestone and shale, SCve-1; OSU-15225.

16. Enlargement of surface ornamentation, X3; Cambridge limestone and shale, Ls-1; OSU-27053.

17-20. *Orthotetes conemaughensis* n. sp.

17, 18. Pedicle interior view of holotype and enlargement of pedicle interior of holotype showing delthyrial chamber, X2; Ames limestone and shale, CAc-2; OSU-27054.

19. Enlargement of parvicostellate ornamentation, X3; Ames limestone and shale, JEwa-1; OSU-27056.

20. Pedicle view of paratype; Ames limestone and shale, CAc-2; OSU-27055.

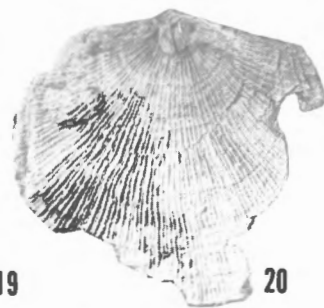
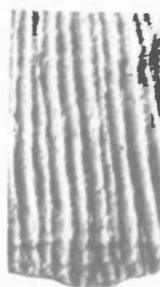
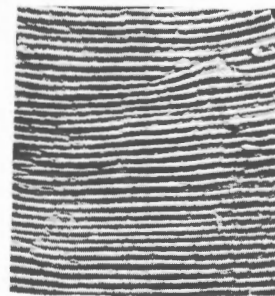
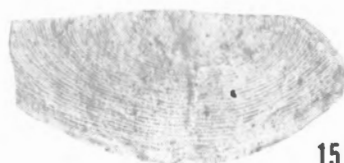
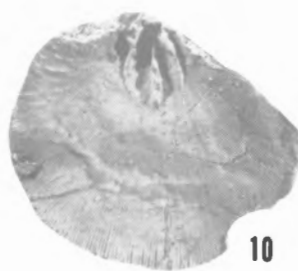
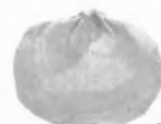
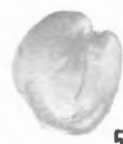


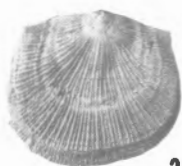
PLATE 3

(All figures X1 except where noted)

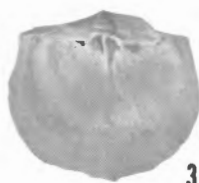
- FIGURES 1-4. *Derbyia crassa* (Meek & Hayden). Brachial, pedicle, pedicle interior, and brachial interior views; Lower Mercer limestone and shale, Hfg-5; OSU-27057 to 27060.
- 5-12. *Derbyia parvicostata* n. sp. Brachial, anterior, pedicle, and lateral views of holotype; brachial, anterior, lateral, and brachial views of paratypes; Ames limestone and shale, Go-1; OSU-27061 to 27063.
- 13, 14. *Derbyia* cf. *D. platsmouthensis* Dunbar & Condra. Brachial and lateral views; Portersville shale and limestone, Pb-1; OSU-27064.
- 15-18. *Derbyia* cf. *D. crassa* var. *subcircularis* Dunbar & Condra.
- 15-17. Brachial, lateral, and pedicle views; Columbiana limestone and shale, Pj-3; OSU-27066.
18. Brachial view; Washingtonville shale, Twa-1; OSU-27065.
19. *Derbyia* sp. Mold of brachial valve; Lower Mercer limestone and shale, SCve-1; OSU-15224.
- 20-23. *Chonetinella crassiradiata* (Dunbar & Condra).
- 20-22. Pedicle, anterior, and brachial views, X2.5; Vanport limestone and shale, Mp-1; OSU-27023.
23. Pedicle view, X2; Vanport limestone and shale, Mp-1; MU-10918.



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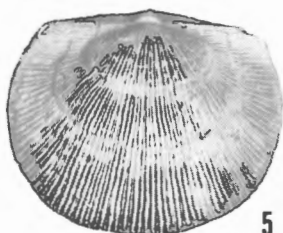
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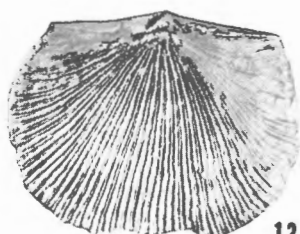
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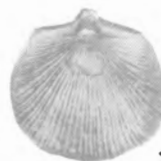
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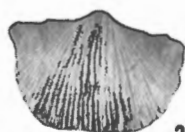
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PLATE 4
(All figures X2.5)

- FIGURES 1-5. *Mesolobus striatus* Weller & McGehee. Brachial interior, pedicle, anterior, pedicle, and anterior views; Putnam Hill limestone and shale, Vel-12; OSU-25947 to 25949.
- 6-15. *Plicochonetes dotus* n. sp. Pedicle and anterior views of holotype; brachial interior, two pedicle, brachial, and four pedicle views of paratypes; Lower Mercer limestone and shale, Vel-6; OSU-25950 to 25958.
- 16-30. *Rugosochonetes delicatus* n. sp.
- 16-19. Two brachial interior, pedicle, and anterior views of paratypes; Lower Mercer limestone and shale, Vel-6; OSU-25959 to 25961.
20. Pedicle interior view of paratype; Lowellville limestone and shale, Mp-3; OSU-25962.
- 21-23. Two brachial and brachial interior views of paratypes; Boggs shale, Tfr-1; OSU-25963 to 25965.
- 24, 25. Pedicle and anterior views of holotype; Boggs shale, Tfr-1; OSU-25966.
- 26-30. Pedicle interior and four pedicle views of paratypes; Boggs shale, Tfr-1; OSU-25967 to 25971.

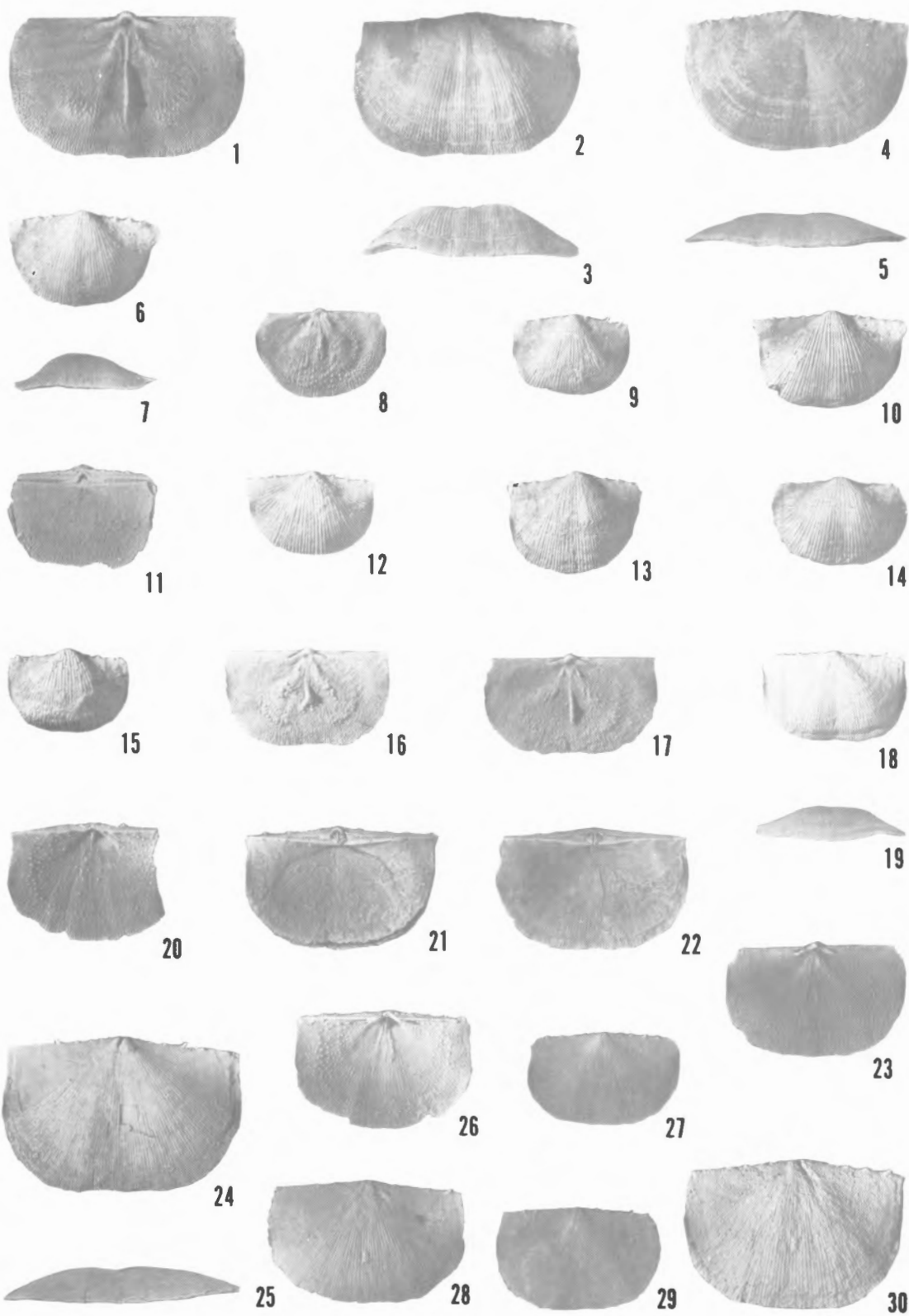


PLATE 5
(All figures X2.5)

FIGURES 1-4. *Chonetinella flemingi* (Norwood & Pratten).

1, 2. Brachial exterior and brachial interior views with attached bryozoan; Cambridge limestone and shale, Ls-1; OSU-25885.

3, 4. Pedicle interior and brachial interior views; Cambridge limestone and shale, Ls-1; OSU-25886, 25887.

5-7. *Chonetinella verneuliana* var.

5, 6. Pedicle and anterior views; Cambridge limestone and shale, Ls-1; OSU-25888.

7. Pedicle view; Portersville shale and limestone, MOy-1; OSU-25889.

8-18. *Chonetinella plebeia* (Dunbar & Condra).

8-13. Brachial interior, two pedicle interior, and three brachial interior views; Lower Brush Creek limestone and shale, At-9; OSU-25890 to 25895.

14-17. Two pedicle, brachial, and anterior views; Brush Creek limestone and shale, At-9; OSU-25896 to 25898.

18. Pedicle interior view; Brush Creek limestone and shale, At-9; OSU-25899.

19-30. *Eolissochonetes fragilis* n. sp.

19-21. Brachial interior, pedicle, and pedicle interior views of paratypes; Washingtonville shale, MUwa-4; OSU-25900 to 25902.

22, 23. Pedicle and anterior views of holotype; Washingtonville shale, MUwa-4; OSU-25903.

24-30. Pedicle, brachial, brachial interior, pedicle interior, brachial interior, brachial, and brachial interior views of paratypes; Washingtonville shale, MUwa-4; OSU-25904 to 25910.

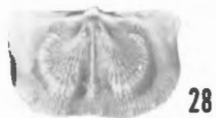
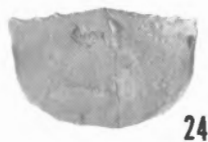


PLATE 6

(All figures X2.5 except where noted)

FIGURES 1-6. *Mesolobus mesolobus* (Norwood & Pratten). Three pedicle and anterior views of specimens illustrated by Girty (1915) of *M. mesolobus* var. *decipiens*. Wewoka Formation, Girty's loc. 2006; X2.

1, 2. Girty's pl. 7, fig. 6; USNM-120906.

3, 4. Girty's pl. 7, fig. 5; USNM-120905.

5, 6. Girty's pl. 7, figs. 7, 7a; USNM-120907.

7-16. *Mesolobus mesolobus* (Norwood & Pratten).

7-9. Pedicle, anterior, and brachial views of neotype; IGS 34P-1.

10-16. Pedicle, anterior, pedicle, anterior, two brachial interior, and pedicle interior views of supporting specimens; shale between the No. 6 caprock and limestone, Solar Coal Co. pit, St. Clair County, Illinois; IGS 34P-2 to 6.

17-24. *Mesolobus mesolobus* (Norwood & Pratten).

17-19. Brachial interior, pedicle interior, and brachial views; Vanport limestone and shale, Vs-3; OSU-25911 to 25913.

20-24. Two pedicle, anterior, pedicle, and anterior views; Washingtonville shale, HOul-1; OSU-25914 to 25916.

25-34. *Mesolobus lioderma* (Dunbar & Condra). Illustrations of Dunbar and Condra's (1932) specimens.

25, 26. Dunbar and Condra's pl. 20, figs. 6, 9; YPM-13531, 13532.

27, 28. Dunbar and Condra's pl. 20, fig. 5; YPM-13531.

29, 30. Dunbar and Condra's pl. 20, fig. 10; YPM-13532.

31, 32. Pedicle and anterior views, Dunbar and Condra's pl. 20, fig. 11; YPM-13532.

33, 34. Pedicle and anterior views, Dunbar and Condra's pl. 20, fig. 8; YPM-13531.



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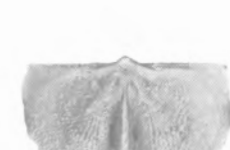
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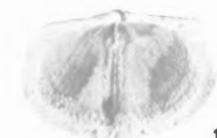
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PLATE 7
(All figures X2.5)

FIGURES 1-9. *Mesolobus lioderma* Dunbar & Condra.

1-6. Pedicle, anterior, pedicle, anterior, and two pedicle views; Columbiana shale and limestone, Cp-3; OSU-25917 to 25920.

7-9. Brachial, brachial interior, and pedicle interior views; Columbiana shale and limestone, Mp-10; OSU-25921 to 25923.

10-19. *Mesolobus obsoletus* n. sp.

10-14. Brachial interior, pedicle interior, anterior, brachial, and anterior views of paratypes; Columbiana shale and limestone, MUwy-1; OSU-25924 to 25926.

15, 16. Pedicle view of paratype and pedicle view of holotype; Vanport limestone and shale, MUho-4; OSU-25927, 25928.

17-19. Pedicle, anterior, and pedicle views of paratypes; Putnam Hill limestone and shale, Tsc-1; OSU-25929, 25930.

20-37. *Mesolobus striatus* Weller & McGehee.

20-26. Brachial interior, brachial, pedicle, pedicle interior, pedicle, anterior, and pedicle interior views; Lower Mercer limestone and shale, Hfg-5; OSU-25931 to 25936.

27-29. Brachial interior, brachial, and pedicle views; Putnam Hill limestone and shale, Vel-11; OSU-25937 to 25939.

30-32. Pedicle interior, pedicle, and brachial views; Putnam Hill limestone and shale, Vel-12; OSU-25940 to 25942.

33-37. Pedicle, two brachial interior, pedicle, and anterior views; Putnam Hill limestone and shale, Vel-15; OSU-25943 to 25946.

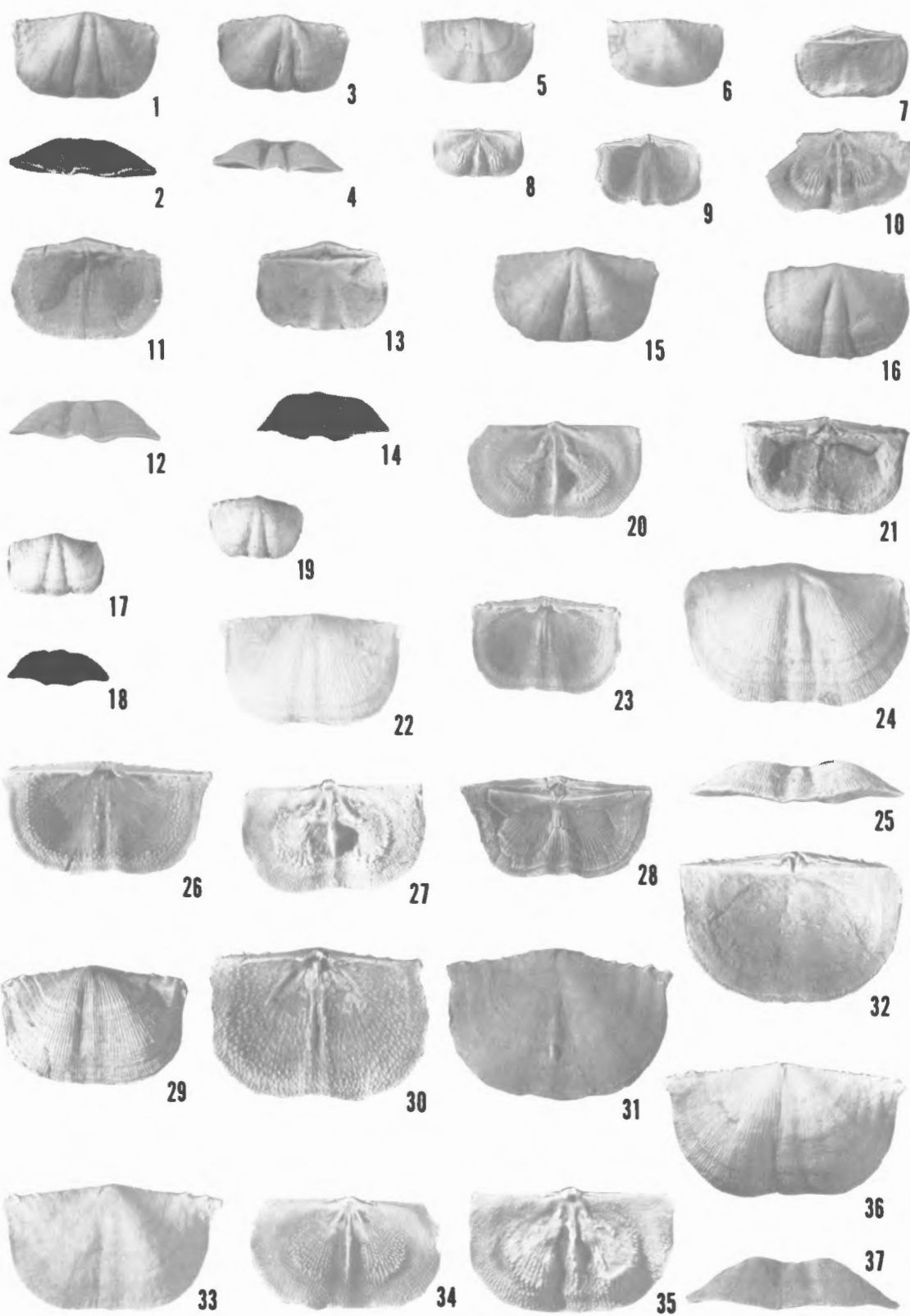


PLATE 8
(All figures X2.5)

FIGURES 1-6. *Neochonetes semiacanthus* (Lintz). Three pedicle, anterior, pedicle interior, and brachial interior views; Ames limestone and shale, No-2; OSU-25867 to 25871.

7-15. *Chonetinella alata* (Dunbar & Condra).

7-11. Two pedicle interior, pedicle, anterior, and brachial interior views; Portersville shale and limestone, Aal-10; OSU-25872 to 25875.

12, 13. Brachial and brachial interior views; Portersville shale and limestone, Pmo-2; OSU-25876, 25877.

14. Brachial valve with attached bryozoan; Portersville shale and limestone, Ad-4; OSU-25878.

15. Pedicle valve with attached *Crania*; Portersville shale and limestone, Pb-1; OSU-25879.

16-21. *Chonetinella flemingi* (Norwood & Pratten).

16. Pedicle view; Cambridge limestone and shale, Ls-1; OSU-25880.

17-19. Pedicle interior, pedicle, and anterior views; Cambridge limestone and shale, Lm-1; OSU-25881, 25882.

20, 21. Brachial and pedicle views; Cambridge limestone and shale, Ls-1; OSU-25883, 25884.



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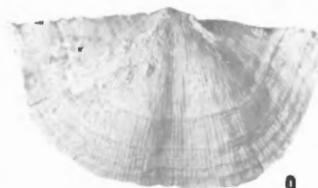
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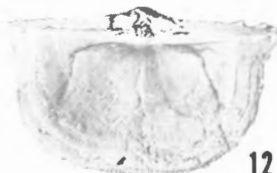
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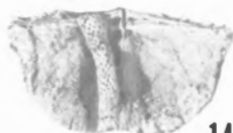
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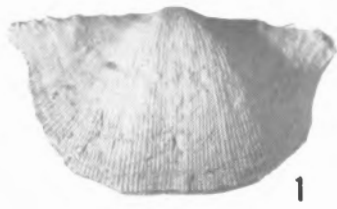


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PLATE 9
(All figures X2.5)

FIGURES 1-19. *Neochonetes granulifer* (Owen).

- 1-7. Pedicle, anterior, two brachial interior, pedicle interior, brachial interior, and pedicle views; Ames limestone and shale, CAc-2; OSU-25851 to 25856.
- 8-17. Brachial, pedicle, anterior, three pedicle interior, two brachial interior, and pedicle views, and pedicle valve with acrothoracic barnacle borings; Ames limestone and shale, Lu-1; OSU-25859 to 25866.
- 18, 19. Pedicle valve with *Crania* attached and pedicle valve with bryozoan attached; Ames limestone and shale, CAc-2; OSU-25857, 25858.



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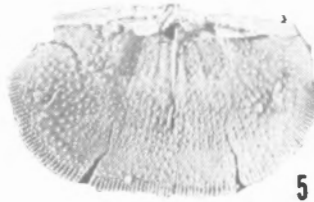
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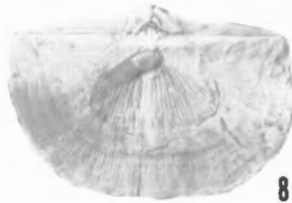
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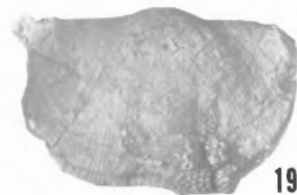
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PLATE 10

(All figures X2 except where noted)

- FIGURES 1-6. *Wellerella osagensis* (Swallow). Brachial, lateral, anterior, brachial, anterior, and lateral views; Ames limestone and shale, JEwa-1; OSU-27067, 27068.
- 7-9. *Wellerella tetrahedra* Dunbar & Condra. Brachial, lateral, and anterior views; Putnam Hill limestone and shale, Mg-5; OSU-27069.
- 10-12. *Hustedia mormoni* (Marcou).
- 10, 11. Brachial and lateral views; Ames limestone and shale, Go-1; OSU-27070.
12. Brachial view; Vanport limestone and shale, Mp-4; OSU-27071.
13. *Hustedia miseri* Mather. Brachial view; Lower Mercer limestone and shale, Vel-6; OSU-27072.
- 14-16. *Cleiothyridina orbicularis* (McChesney). Brachial, lateral, and anterior views; Washingtonville shale, CSv-3; OSU-27073.
- 17, 18. *Cleiothyridina orbicularis* var. *crassalamellosa* n. var. Brachial and posterior views of paratype; Lower Mercer limestone and shale, Mc-4; OSU-27075.
- 19, 20. *Leptalosia ovalis* Dunbar & Condra.
19. Pedicle valve attached to crinoid stem, X3; Ames limestone and shale, CAc-2; OSU-27024.
20. Pedicle valve attached to *Composita subtilita*, X3; Ames limestone and shale, Go-1; OSU-27025.
21. *Linoproductus* cf. *L. platyumbonus* Dunbar & Condra. Pedicle view showing several nearly complete hinge spines, X1; Lower Brush Creek limestone and shale, Aa-41; OSU-27027.
22. *Reticulatia rugatia* n. sp. Fragment of pedicle valve showing several nearly complete hinge spines, X1; Vanport limestone and shale, Vs-3; OSU-27026.

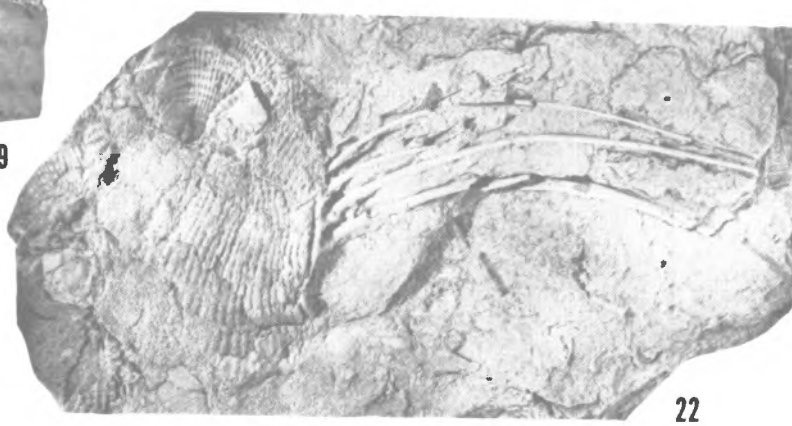
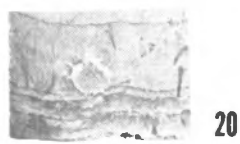
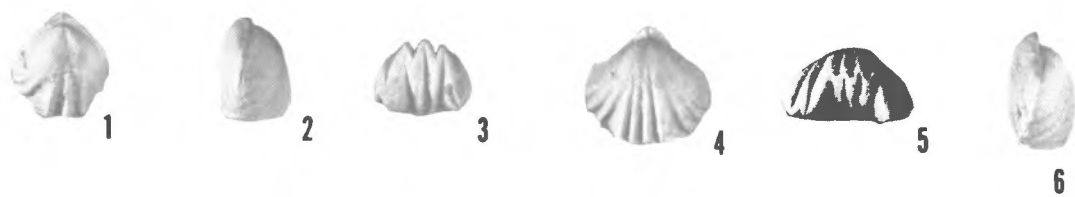


PLATE 11

(All figures X1 except where noted)

FIGURES 1-5. *Cancrinella boonensis* (Swallow).

- 1-3. Pedicle, posterior, and lateral views, X2; Brush Creek limestone and shale, Ale-19; OSU-27016.
4. Pedicle view, X2; Brush Creek limestone and shale, Ale-33; OSU-27017.
5. Pedicle view, X2; Ames limestone and shale, MUu-2; OSU-14108.
6. *Cancrinella* sp. Pedicle view, Putnam Hill limestone and shale, Vel-15; OSU-27018.
7. ?*Fimbriaria* sp. Pedicle view, X4; Ames limestone, Ay-61; OSU-27022.
- 8-13. *Antiquatonia portlockiana* (Norwood & Pratten).
 8. Brachial interior with partial pedicle valve; Ames limestone and shale, CAc-2; OSU-26011.
 - 9-13. Brachial interior, pedicle, lateral, posterior, and pedicle views; Lower Brush Creek limestone and shale, Aa-41; OSU-26012 to 26014.
- 14-21. *Antiquatonia portlockiana* var. *crasscostata* (Dunbar & Condra).
 - 14-17. Posterior, pedicle, lateral, and pedicle views; Cambridge limestone and shale, Gwe-1; OSU-26015, 26016.
 - 18-21. Brachial interior, lateral brachial interior, brachial interior, and pedicle interior views; Cambridge limestone and shale, Ls-1; OSU-26017 to 26019.
- 22-28. *Antiquatonia costellata* n. sp.
 - 22, 28. Internal mold of pedicle valve and brachial views of paratypes; Upper Mercer limestone and shale, Vr-1; OSU-26028, 26029.
 - 23-27. Brachial interior view of paratype, lateral, pedicle, and posterior views of holotype, and pedicle view of paratype; Lower Mercer limestone and shale, Vel-6; OSU-26030 to 26032.

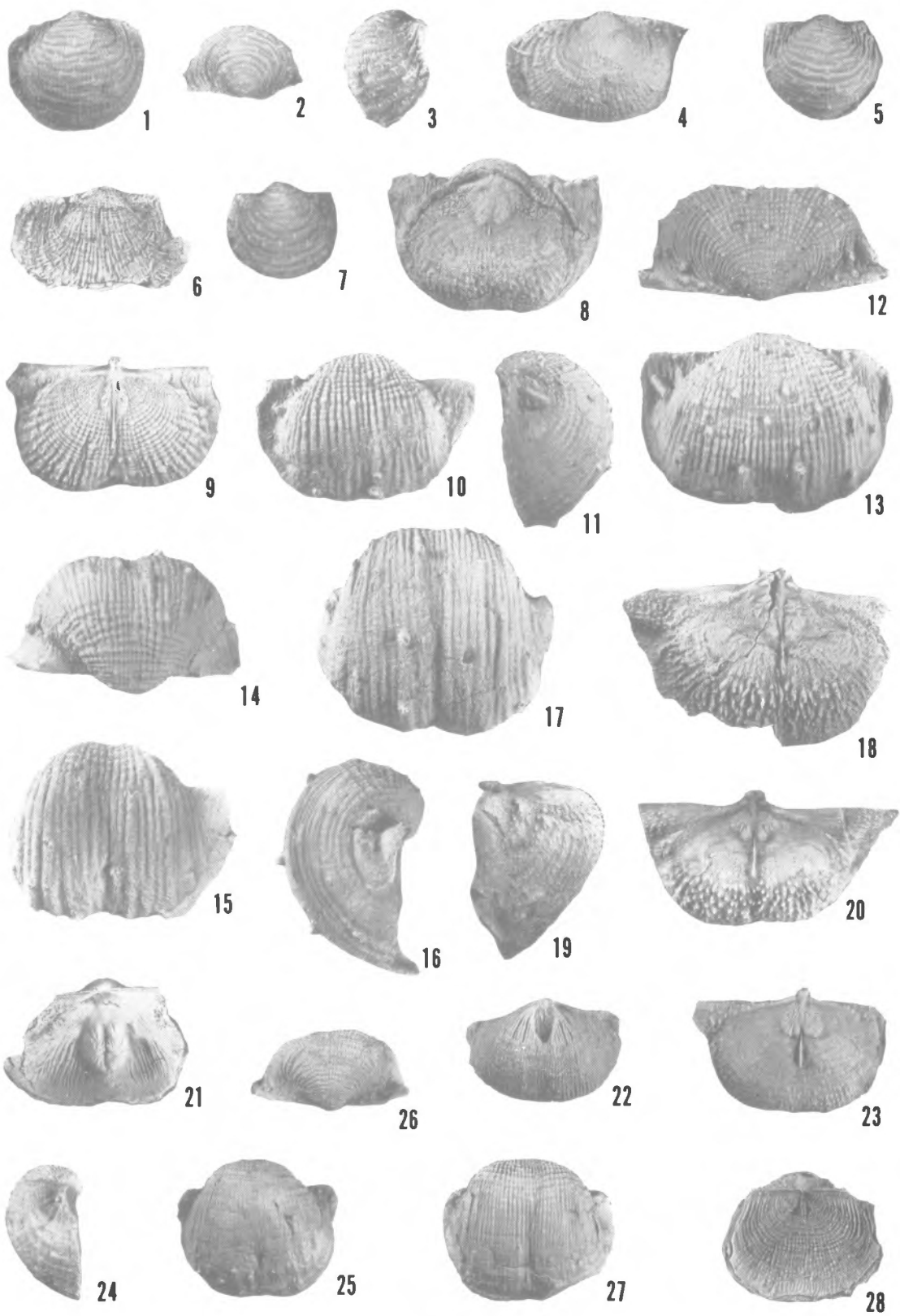


PLATE 12
(All figures X2)

FIGURES 1-5. *Kozlowskia haydenensis* (Girty).

- 1, 2. Pedicle and lateral views; Lower Mercer limestone and shale, Hs-3; OSU-25974.
3. Brachial interior view; Putnam Hill limestone and shale, Vel-12; OSU-25975.
4. Brachial interior view; Putnam Hill limestone and shale, Vel-11; OSU-25976.
5. Brachial view; Lower Mercer limestone and shale, Hfg-5; OSU-25977.

6-10. *Kozlowskia splendens* (Norwood & Pratten).

- 6-9. Brachial interior, brachial, lateral, and pedicle views; Lower Brush Creek limestone and shale, Aa-41; OSU-25978 to 25980.
10. Brachial interior view; Cambridge limestone and shale, Gwe-1; OSU-25981.

11-14. *Hystriaculina wabashensis* (Norwood & Pratten).

- 11-13. Pedicle, lateral, and brachial views; Ames limestone, JEwa-1; OSU-25982.
14. Brachial interior view; Ames limestone, Aa-50; OSU-25984.

15-19. *Desmoinesia muricatina* var. *missouriensis* (Girty).

- 15-18. Pedicle, brachial interior, pedicle, and lateral views; Lower Mercer limestone and shale, Vel-6; OSU-25988 to 25990.
19. Internal mold of pedicle valve; Lower Mercer limestone and shale, Vr-1; OSU-25991.

20-23. *Desmoinesia muricatina* (Dunbar & Condra).

20. Pedicle view; Washingtonville shale, Twa-1; OSU-25985.
- 21, 22. Pedicle and lateral views; Putnam Hill limestone and shale, HOB & HOH-1; OSU-25986.
23. Brachial interior view; Putnam Hill limestone and shale, CSv-4; OSU-25987.

24-26. *Krotovia paucispina* n. sp.

24. Pedicle view of paratype; Lower Mercer limestone and shale, Vel-7; OSU-27019.
- 25, 26. Pedicle view of paratype and pedicle view of holotype; Lower Mercer limestone and shale, Vel-6; OSU-27020, 27021.
- 27, 28. *Krotovia* sp. Posterior and pedicle views; Putnam Hill limestone and shale, Huc-1; OSU-9792.

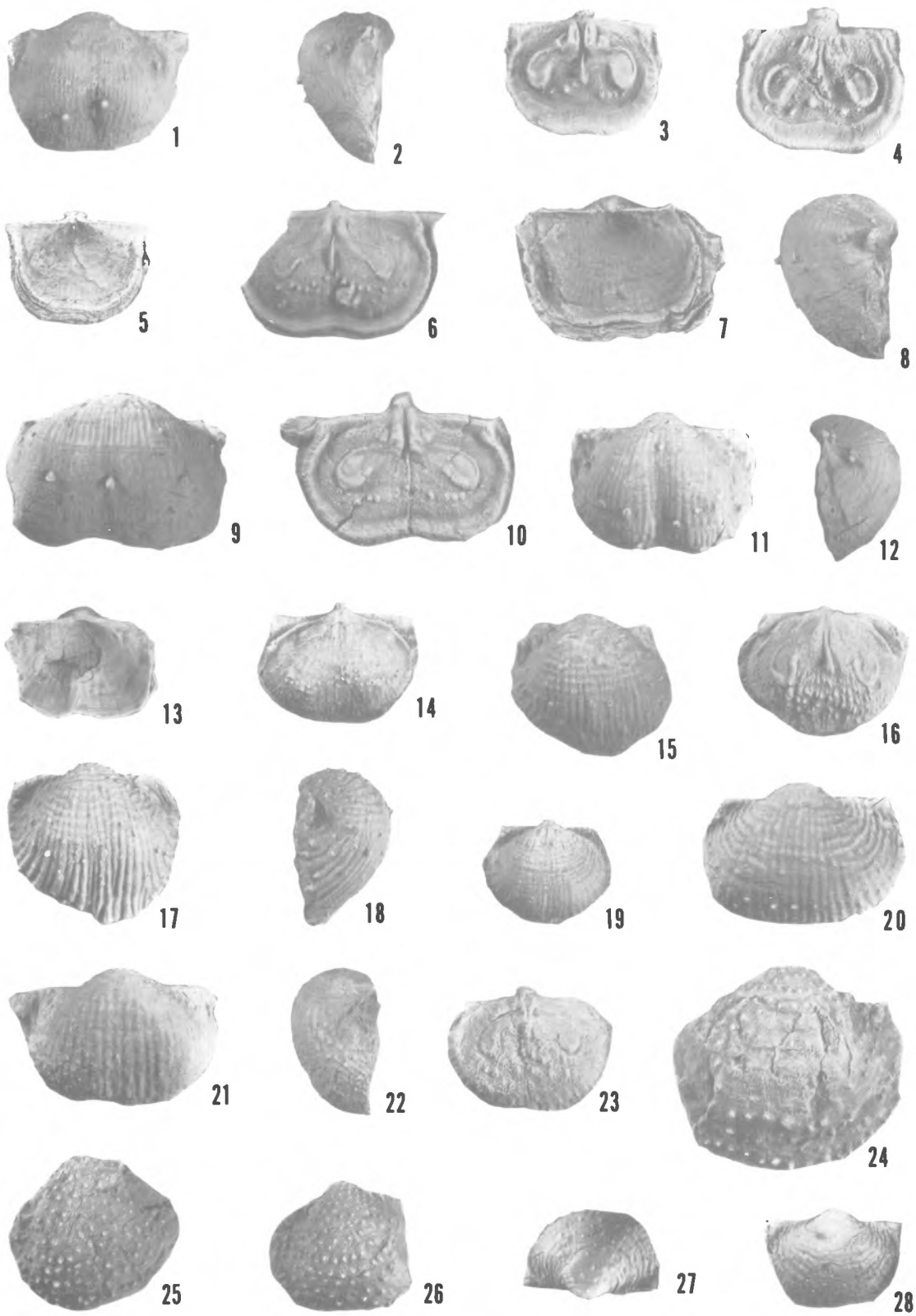


PLATE 13
(All figures X1)

FIGURES 1-7. *Echinaria semipunctata* (Shepard).

- 1, 2. Pedicle and lateral views; Cambridge limestone and shale, Gwe-1; OSU-25999.
- 3-7. Pedicle interior, three brachial interior, and brachial views; Cambridge limestone and shale, Ls-1; OSU-26000 to 26004.



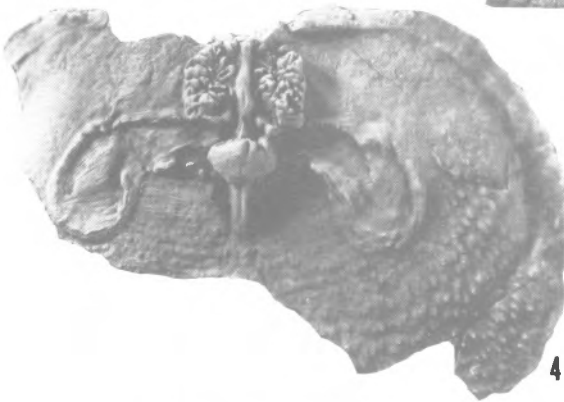
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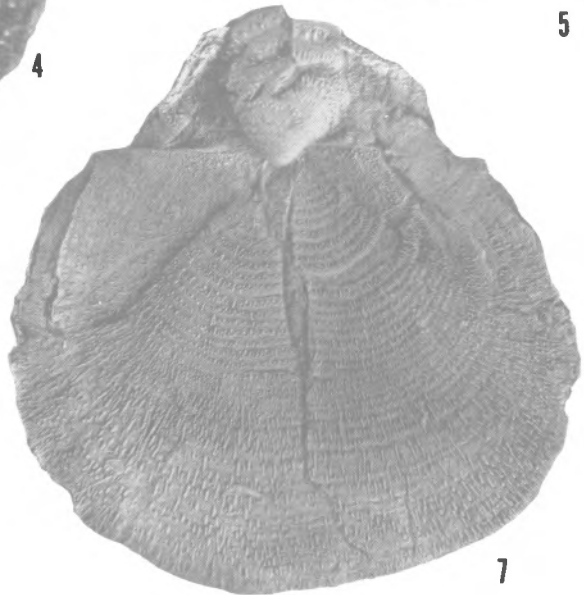
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PLATE 14
(All figures X1)

FIGURES 1-5. *Echinaria moorei* (Dunbar & Condra).

1-3. Pedicle, lateral, and brachial views; Ames limestone and shale, Aam-19; OSU-26008.

4, 5. Two brachial interior views; Ames limestone and shale, CAc-2; OSU-26009, 26010.

6-9. *Echinaria semipunctata* var. *knighti* (Dunbar & Condra). Brachial interior, lateral, pedicle, and mold of pedicle interior views; Vanport limestone and shale, Pcl-1; OSU-26005 to 26007.

10-16. *Reticulatia rugatia* n. sp.

10-13. Lateral, pedicle, brachial interior, and brachial views of paratypes; Columbiana limestone and shale, Mg-7; OSU-26037, 26038.

14. Posterior view of paratype; Columbiana limestone and shale, Mg-6; OSU-26039.

15. Pedicle view of holotype; Putnam Hill limestone and shale, Me-1; OSU-26040.

16. Pedicle interior view of paratype; Columbiana limestone and shale, Pj-3; OSU-26041.



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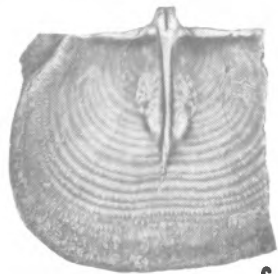
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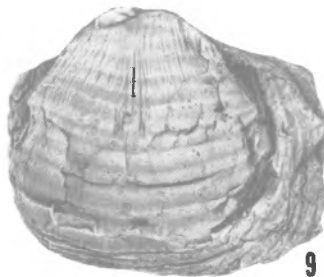
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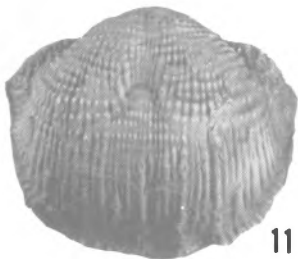
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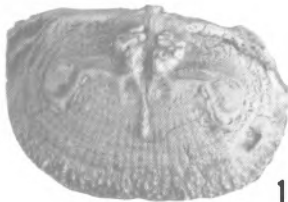
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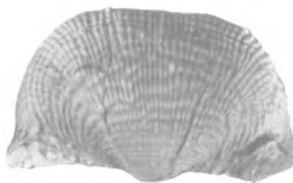
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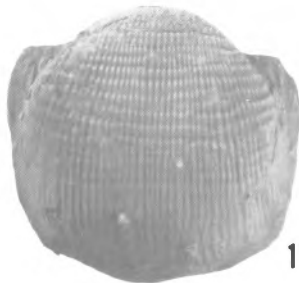
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PLATE 15
(All figures X1)

FIGURES 1-11. *Antiquatonia portlockiana* var. *quadrata* n. var.

1-9. Posterior, pedicle, and lateral views of holotype; pedicle, lateral, brachial, pedicle interior, and two brachial interior views of paratypes; Lower Mercer limestone and shale, Hfg-5; OSU-26020 to 26025.

10. Pedicle view of paratype; Lower Mercer limestone and shale, Hs-3; OSU-26026.

11. Internal mold of pedicle valve of paratype; Lower Mercer limestone and shale, Pr-1; OSU-26027.

12-17. *Pulchratia symmetrica* var. *regularis* n. var.

12. Pedicle view of paratype; Brush Creek limestone and shale, MOB-1; OSU-25992.

13. Brachial interior view of paratype; Brush Creek limestone and shale, Ale-18; OSU-25993.

14, 15. Lateral and pedicle views of holotype; Brush Creek limestone and shale, Ale-19; OSU-25994.

16, 17. Brachial and brachial interior views of paratypes; Brush Creek limestone and shale, Ale-18; OSU-25995, 25996.

18-20. *Pulchratia* cf. *P. ovalis* (Dunbar & Condra). Pedicle, lateral, and brachial interior views; Ames limestone and shale, CAc-2; OSU-25997, 25998.

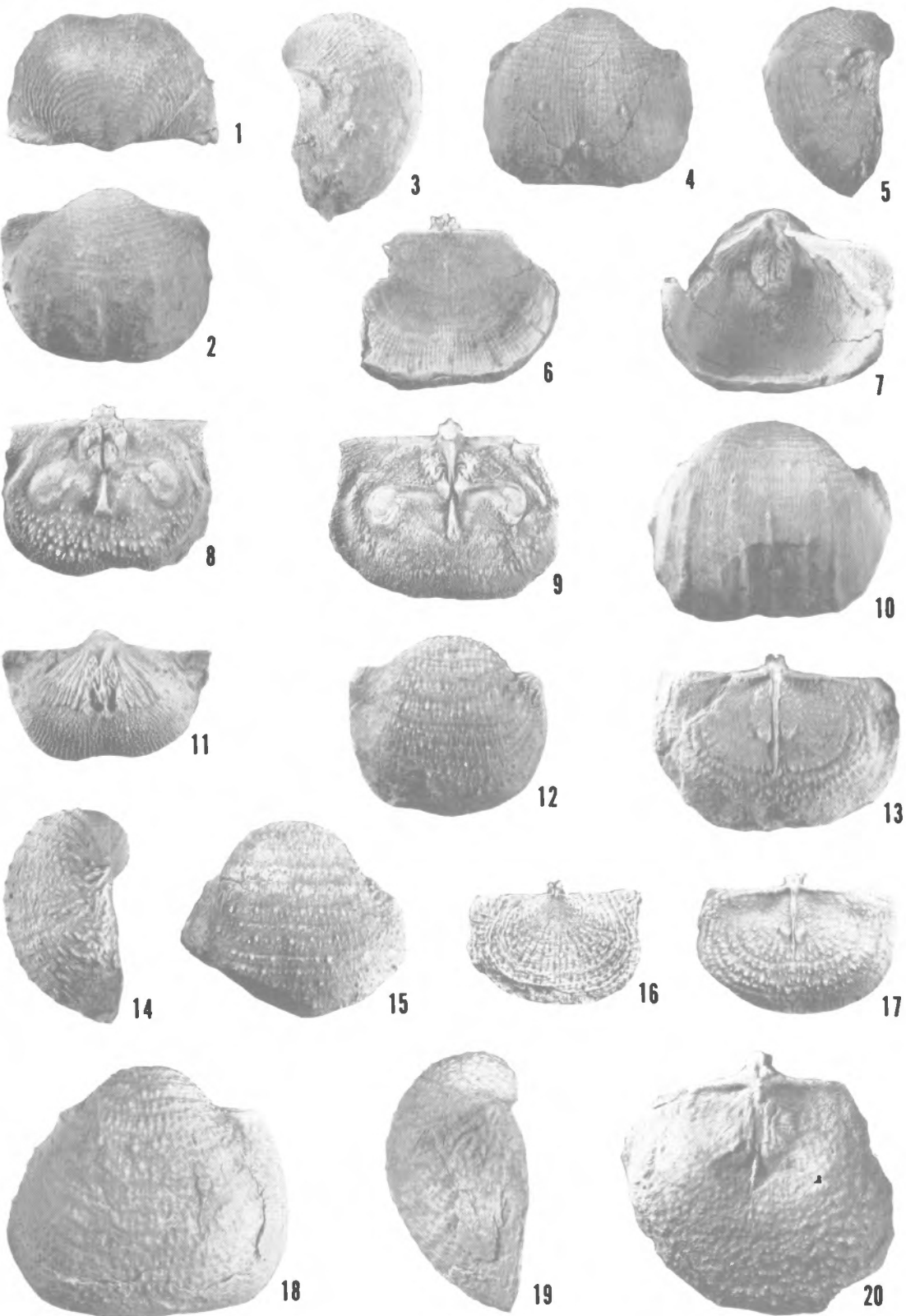


PLATE 16
(All figures X1)

FIGURES 1-4. *Reticulatia buecoensis* (R. E. King). Two brachial interior, partial pedicle, and brachial views; Ames limestone and shale, CAc-2; OSU-26033 to 26036.

5-9. *Juresania nebrascensis* var. *inflata* n. var.

5. Brachial interior view of a paratype; Lower Mercer limestone and shale, Pr-2; OSU-26046.

6. Brachial view of a paratype; Lower Mercer limestone and shale, Pmc-2; OSU-26047.

7-9. Lateral, posterior, and pedicle views of holotype; Lower Mercer limestone and shale, POa & POd-1; OSU-26048.

10-14. *Juresania nebrascensis* var. *pulchra* n. var.

10. Brachial interior view of a paratype; Brush Creek limestone and shale, Ale-19; OSU-26049.

11-14. Pedicle and lateral views of holotype, posterior and pedicle views of paratypes; Brush Creek limestone and shale, Ale-18; OSU-26050, 27001, 27002.

15-21. *Juresania nebrascensis* (Owen).

15-18. Brachial, posterior, pedicle, and lateral views; Lower Brush Creek limestone and shale, Aa-41; OSU-26042.

19. Pedicle view; Brush Creek limestone and shale, Ale-19; OSU-26043.

20. Brachial interior view; Ames limestone and shale, CAc-1; OSU-26044.

21. Brachial interior view; Ames limestone and shale, CAc-2; OSU-26045.

22, 23. *Linoproductus planiventralis* Hoare.

22. Pedicle view; Lower Mercer limestone and shale, Hfg-5; OSU-27004.

23. Brachial interior view; Lower Mercer limestone and shale, SUG-1; OSU-27005.

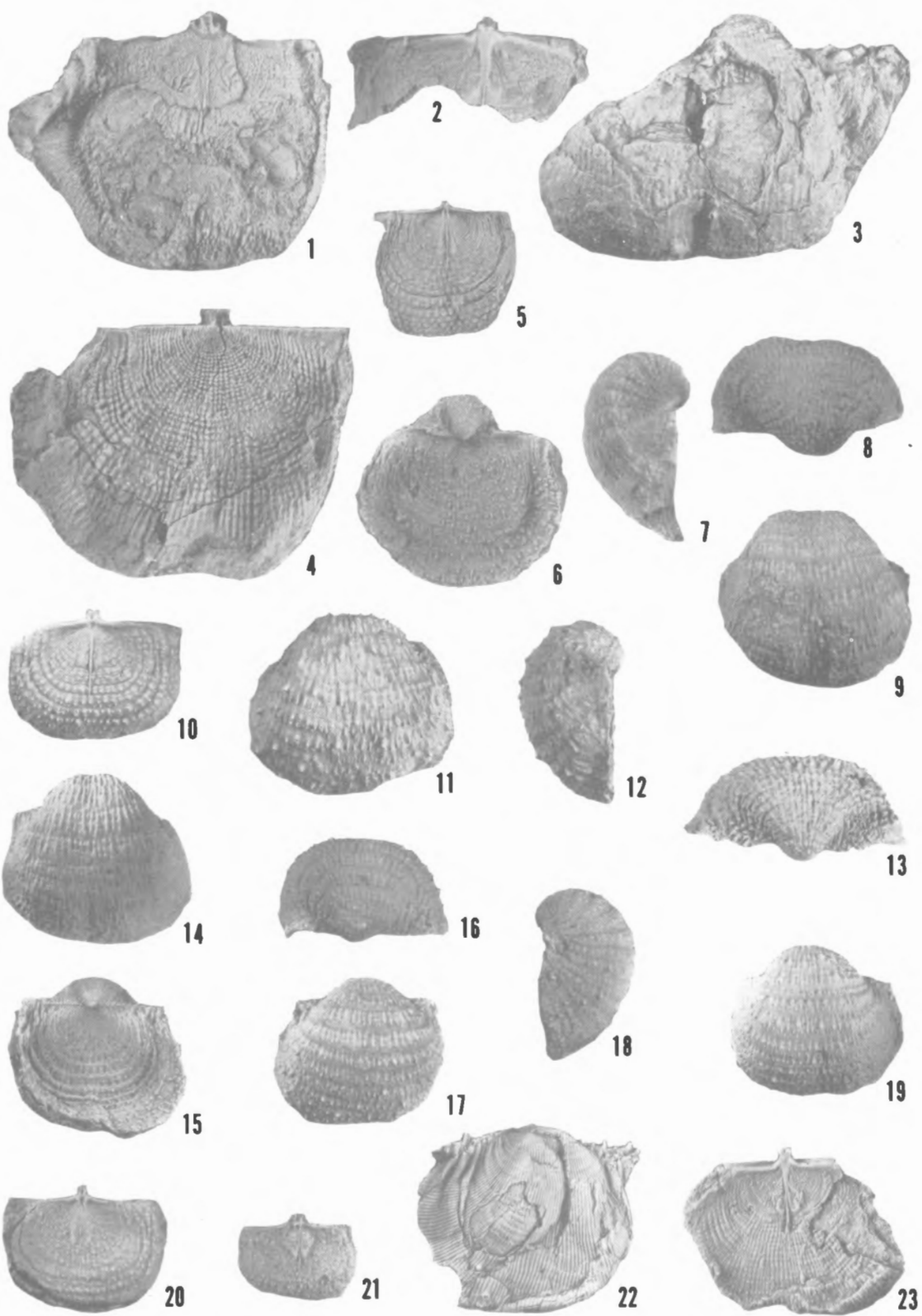


PLATE 17
(All figures X1)

FIGURES 1-3. *Linoproductus prattenianus* (Norwood & Pratten).

1. Pedicle view; Lower Brush Creek limestone and shale, Aa-41; OSU-27011.

2, 3. Posterior and brachial interior view; Ames limestone, CAc-2; OSU-27012, 27013.

4, 5, 9, 10. *Linoproductus echinatus* Hoare. Pedicle, lateral, posterior, and pedicle views; Cambridge limestone and shale, Ls-1; OSU-27007, 27008.

6-8. *Linoproductus oklahomae* Dunbar & Condra. Lateral, posterior, and pedicle views; Ames limestone, Aa-14; OSU-27003.

11, 12, 14. *Linoproductus* cf. *L. magnispinus* Dunbar & Condra.

11, 12. Posterior and pedicle views; Ames limestone, Auc-1; OSU-27009.

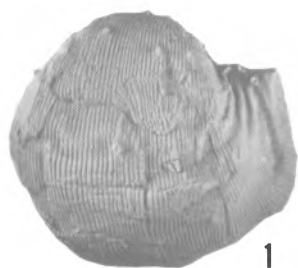
14. Pedicle view; Cambridge limestone and shale, Gwe-1; OSU-27010.

13. *Linoproductus planiventralis* Hoare. Posterior view; Lower Mercer limestone and shale, Vr-1; OSU-27006.

15-17. *Linoproductus* cf. *L. platyumbonus* Dunbar & Condra.

15. Pedicle view; Brush Creek limestone and shale, Ale-18; OSU-27014.

16, 17. Posterior and pedicle views; Ames limestone and shale, Aa-3; OSU-27015.



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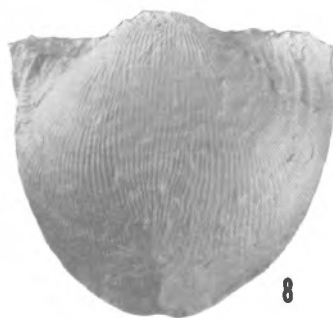
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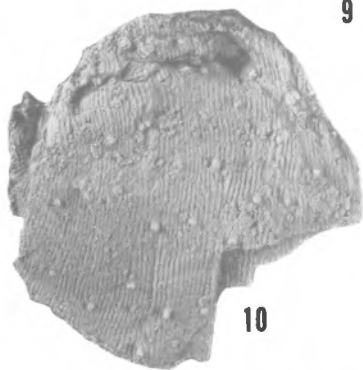
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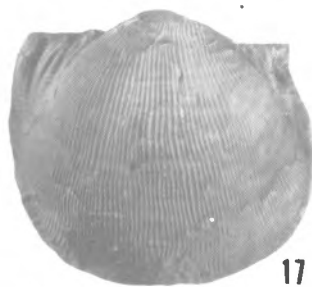
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PLATE 18

(All figures X1 except where noted)

- FIGURES 1-4. *Cleiothyridina orbicularis* var. *crassalamellosa* n. var. Brachial, pedicle, anterior, and lateral views of holotype, X2; Lower Mercer limestone and shale, Mc-4; OSU-27074.
- 5-10. *Composita subtilita* (Hall).
- 5-8. Brachial, pedicle, anterior, and lateral views; Ames limestone and shale, Go-1; OSU-27076.
- 9, 10. Brachial and anterior views; Washingtonville shale, CSv-3; OSU-27077.
- 11-18. *Composita ovata* Mather.
- 11-13. Brachial, anterior, and lateral views; Brush Creek limestone and shale, Ale-19; OSU-27078.
- 14-16. Brachial, pedicle, and anterior views; Brush Creek limestone and shale, Ale-18; OSU-27079.
- 17, 18. Brachial and anterior views; Washingtonville shale, CSv-3; OSU-27080.
- 19-24. *Composita argentea* (Shepard). Brachial, anterior, lateral, brachial, lateral, and anterior views; Vanport limestone and shale, Vs-3; OSU-27081, 27082.
- 25-30. *Composita magna* Newell.
- 25-27. Brachial, anterior, and lateral views; Gaysport limestone and shale, Aam-20; OSU-27084.
- 28-30. Anterior, pedicle, and brachial views of internal mold; Skelley limestone and shale, Aam-7; OSU-27083.

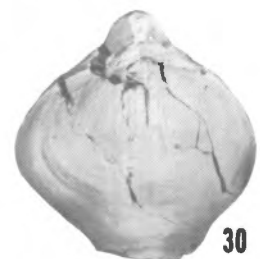
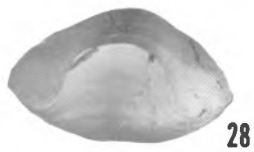
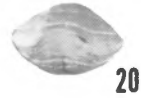


PLATE 19

(All figures X1 except where noted)

- FIGURES 1-3. *Composita elongata* Dunbar & Condra. Brachial, anterior, and lateral views; Putnam Hill limestone and shale, Mc-1; OSU-27085.
- 4-14. *Composita ohioense* n. sp.
- 4-7. Brachial, pedicle, lateral, and anterior views of holotype; Cambridge limestone and shale, Ls-1; OSU-27086.
- 8-13. Brachial, lateral, pedicle, anterior, brachial, and anterior views of paratypes; Cambridge limestone and shale, Ls-1; OSU-27087, 27088.
14. Pedicle view of paratype with *Spirorbis* attached, X3; Cambridge limestone and shale, Ls-1; OSU-27090.
- 15-20. *Composita girtyi* Raymond.
- 15-17, 19, 20. Brachial, lateral, anterior, brachial, and lateral views; Vanport limestone and shale, Mp-2; OSU-27091, 27093.
18. Brachial view; Vanport limestone and shale, Spk-1; OSU-27092.
- 21-25. *Crurithyris planoconvexa* (Shumard).
- 21-23. Brachial, lateral, and pedicle views, X2; Ames limestone and shale, JEwa-1; OSU-27094.
24. Brachial interior view, X2; Ames limestone and shale, Aal-9; OSU-27096.
25. Pedicle interior view, X2; Ames limestone and shale, Aam-7; OSU-27095.
- 26-29. *Anthracospirifer rockymontanus* (Marcou). Pedicle, brachial, lateral, and anterior views; Putnam Hill limestone and shale, CSv-4; OSU-27097.
- 30-32. *Anthracospirifer opimus* (Hall). Brachial, pedicle, and lateral views; Upper Mercer limestone and shale, Vel-7; OSU-27098.

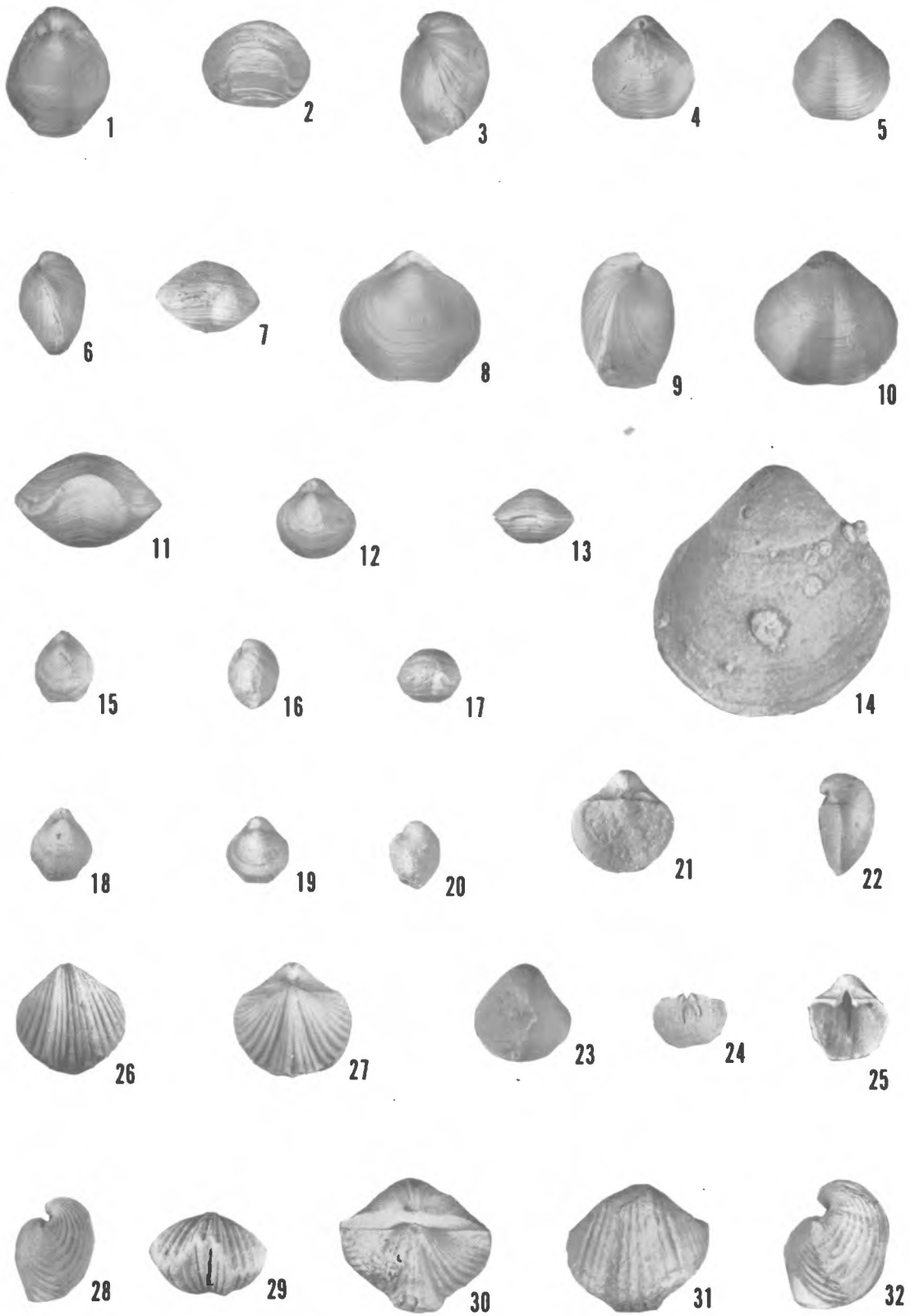


PLATE 20
(All figures X1)

FIGURES 1-7. *Anthracospirifer occiduus* (Sadlick).

1. Pedicle view; Lower Mercer limestone and shale, Vel-7; OSU-27099.
2. Brachial view; Lower Mercer limestone and shale, Hfg-5; OSU-27100.
3. Pedicle interior view; Putnam Hill limestone and shale, Vel-11; OSU-27101.
- 4-7. Brachial, posterior, pedicle, and lateral views of an internal mold; Lower Mercer limestone and shale, Vr-1; OSU-27102.

8-15. *Neospirifer dunbari* R. H. King.

- 8-12. Lateral, brachial, anterior, brachial, and pedicle views; Ames limestone and shale, Go-1; OSU-27103, 27104.
- 13-15. Brachial, anterior, and lateral views; Lower Brush Creek limestone and shale, Aa-41; OSU-27105.

- 16, 17. *Neospirifer latus* Dunbar & Condra. Pedicle and lateral views; Portersville shale and limestone, Aa-51; OSU-27106.



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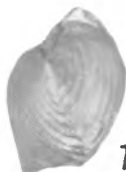
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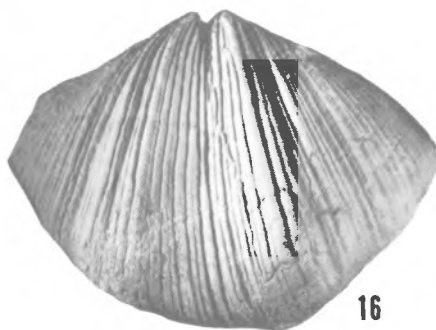
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PLATE 21
(All figures X1)

- FIGURES 1-4. *Neospirifer latus* Dunbar & Condra. Brachial interior, brachial, pedicle interior, and pedicle views; Portersville shale and limestone, Aa-12; OSU-27108, 27107.
- 5-8. *Neospirifer cameratus* (Morton).
5. Brachial view; Vanport limestone and shale, Ms-5; OSU-27110.
- 6-8. Brachial, anterior, and lateral views; Putnam Hill limestone and shale, CSv-4; OSU-27109.
- 9-12. *Neospirifer goreii* (Mather).
- 9, 10. Two brachial views; Upper Mercer limestone and shale, Pmc-3; OSU-27112, 27111.
- 11, 12. Pedicle and brachial views; Lower Mercer limestone and shale, Luc-1; OSU-27114, 27113.



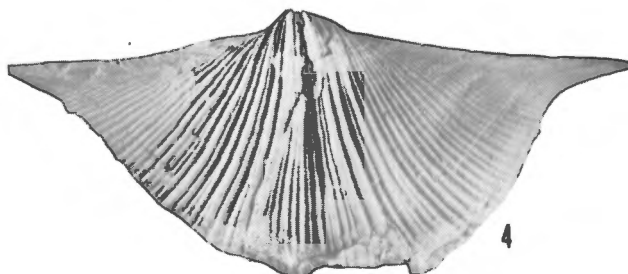
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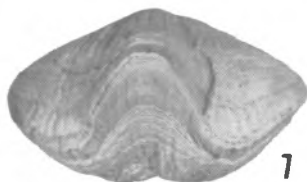
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PLATE 22

(All figures X2 except where noted)

- FIGURES 1-4. *Punctospirifer kentuckyensis* (Shumard). Brachial, pedicle, brachial interior, brachial views; Lower Mercer limestone and shale, Hfg-5; OSU-27115, 27116.
- 5-9. *Punctospirifer kentuckyensis* var. *amesi* n. var.
- 5, 7. Brachial and pedicle views of holotype; Ames limestone and shale, Go-1; OSU-27117.
6. Enlarged view of fold and sulcus of holotype, X10.
- 8, 9. Brachial and lateral views of paratype; Ames limestone and shale, Go-1; OSU-27118.
- 10-14. *Phricodothyris perplexa* (McChesney).
- 10-12. Lateral, brachial, and anterior views; Columbiana limestone and shale, Mg-6; OSU-27119.
- 13, 14. Brachial view, X1, and enlarged brachial view showing surface ornamentation and flangelike deltidial plates, X5; Washingtonville shale, CSv-3; OSU-27120.
- 15-19. *Beecheria bovidens* (Morton).
15. Brachial view; Putnam Hill limestone and shale, Hoh & Hob-1; OSU-27123.
16. Brachial view of internal mold, X4; Vanport limestone and shale, Jf-1; OSU-27122.
- 17-19. Lateral, brachial, and anterior views; Putnam Hill limestone and shale, MUmu-2; OSU-27121.

